United States
Department of
Agriculture

Soil
Conservation
Service

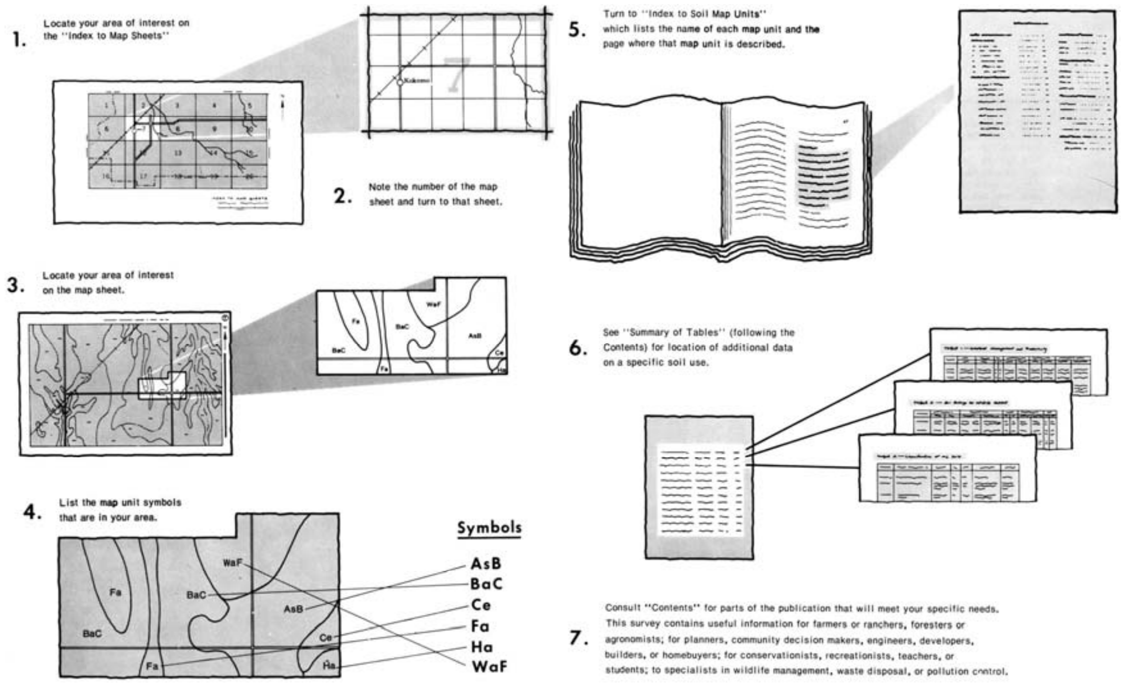
In cooperation with
Texas Agricultural
Experiment Station

Soil Survey of Irion County, Texas

ELECTRONIC VERSION

This soil survey is an electronic version of the original printed copy, dated April 1986. It has been formatted for electronic delivery. Additional and updated information may be available from the Web Soil Survey. In Web Soil Survey, identify an Area of Interest (AOI) and navigate through the AOI Properties panel to learn what soil data is available.

HOW TO USE THIS SOIL SURVEY



This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1981. Soil names and descriptions were approved in 1983. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Middle Concho Soil and Water Conservation District.

Cover: West Rocky Creek was once a dry creek. It resumed continuous flow after most of the mesquite trees were removed and better use was made of the rangeland. Along the banks the soils are in the Rioconcho-Dev association, frequently flooded.

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Foreword

This soil survey contains information that can be used in land-planning programs in Irion County, Texas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Billy C. Griffin

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State Conservationist
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Soil Survey of Irion County, Texas

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United States Department of Agriculture, Soil Conservation Service
In cooperation with
the Texas Agricultural Experiment Station

IRION COUNTY is in the west-central part of Texas (fig. 1). The total area of the county is 673,191 acres, or about 1,052 square miles. Mertzon is the county seat. Barnhart and Sherwood are two other towns in the county.

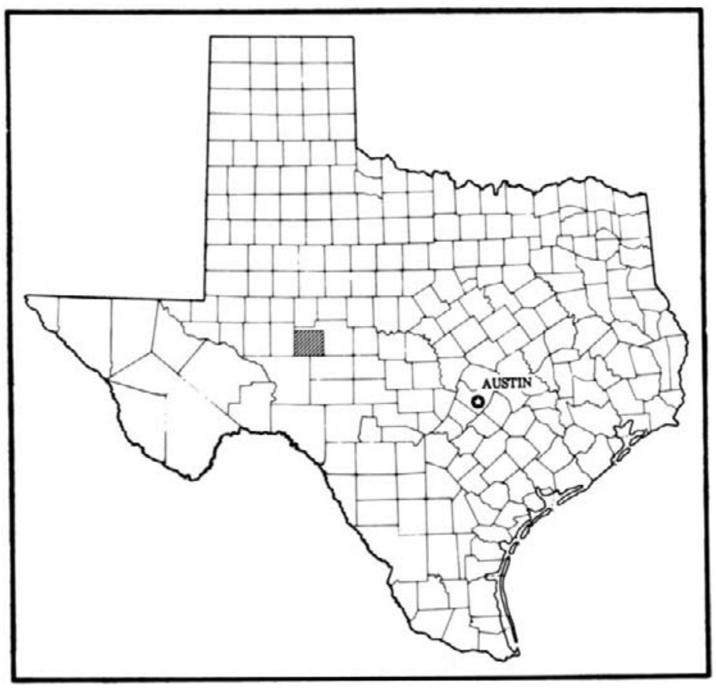

Figure 1.—Location of Irion County in Texas.

Settlement of the county began in the 1860's (4). Large wintering herds of bison still reached the area in the 1860's, but by 1876-77 only small groups came to winter. One of the first cattle ranches was started by R. F. Tankersley in 1864. John Arden brought in the first big flock of sheep from California in 1876. The railroads reached the area in 1883, and the first wire fences were strung about 1884. By the 1890's, the range was heavily stocked with both sheep and cattle.

In 1878, there were only scattered families along Spring Creek. In 1890 the population of the county was 870, and by 1980 it was 1,386. In 1970, Mertzon had 513 residents, Barnhart had 74, and Sherwood had 47.

Of the total land area, 659,800 acres is rangeland, 5,200 acres is cropland, and the rest is urban or other land. Irrigated land in 1979 amounted to 1,970 acres.

In 1979, about 97 percent of the agricultural income was from livestock, and 3 percent was from cotton, hay, and sorghum crops.

General Nature of the Survey Area

The history; climate; physiography, relief, and drainage; and natural resources of the county are briefly described in this section.

History

An early written record of Irion County was Juan Dominquez de Mendoza's account of his expedition through the area in 1683 *(5).* Mendoza traveled eastward along Centralia Draw and the Middle Concho River. He described campsites at the mouth of Kiowa Creek and near Irion City, of which nothing remains. He mentioned very tall pecan and live oak trees and pricklypear cactus. The valley at Irion City was described as barren, with no wood except pecan trees. Near the mouth of Kiowa Creek, the valley was said to be quite barren except adjacent to the stream. The hills beyond the valley were said to have no shrubs or trees and were covered with stones and rocks.

In 1850, the area east of Mertzon was described as barren, with no wood but stunted mesquite. Prairie dogs continued from an abundant population around San Angelo (Tom Green County). The eastern peak of the Lopez Peaks was described as barren. In 1982, however, junipers were abundant on the peak.

Small mesquites were mentioned in the middle 19th century, but juniper was rarely mentioned until the beginning of the 20th century. By 1901, the hills between San Angelo and Sherwood were covered with a growth of oak brush and juniper. Mesquite was said to be abundant almost everywhere. The droughts of the 30's and 50's each caused an additional increase in mesquite. Juniper is now abundant north and west of Mertzon.

This dramatic change in woody plants was brought about by a change from sporadic or intermittent grazing to continuous grazing, by a change in the kinds of grazing animals, and by a reduction in prairie fires. The grazing animals before settlement were bison, prairie dogs, and pronghorn. In most areas these were replaced by cattle, sheep, horses, and goats.

The Butterfield Overland Mail route along the Middle Concho River *(6)* was used as a stage route from 1858 to 1861. This route is still visible in many places and is indicated on the soil maps at the back of this survey (fig. 2).

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Irion County has hot summers and fairly warm winters. Cold spells or snowfalls are rare. Rains are usually heaviest late in spring and early in fall. Rain in the fall is often associated with a dissipating tropical storm. Total annual precipitation is usually adequate for range vegetation, but because of the high rate of evapotranspiration, it often is inadequate for good yields of cotton, small grains, and sorghum without supplemental irrigation.

Table 1 gives data on temperature and precipitation for the survey area as recorded at San Angelo in the period 1951 to 1978. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 48 degrees F, and the average daily minimum temperature is 35 degrees. The lowest temperature on record, which occurred at San Angelo on February 2, 1951, is 1 degree. In summer the average temperature is 83 degrees, and the average daily maximum temperature is 95 degrees. The highest recorded temperature, which occurred on July 29, 1960, is 111 degrees.

Figure 2.—Ruins on the Butterfield Trail. The trail is still used by ranch vehicles. The soil is Broome silt loam, 1 to 3 percent slopes.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 18 inches. Of this, 12 inches, or 65 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 8 inches. The heaviest 1-day rainfall during the period of record was 4.97 inches at San Angelo on October 3, 1959. Thunderstorms occur on about 35 days each year, and most occur in spring.

The average seasonal snowfall is 3 inches. The greatest snow depth at any one time during the period of record was 6 inches. On an average, only 1 day has at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 45 percent. Humidity is higher at night, and the average at dawn is about 75 percent. The sun shines 75 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in spring.

Physiography, Relief, and Drainage

Irion County is mostly within the Edwards Plateau Land Resource Area. The soils are underlain by limestone of Lower Cretaceous age that is nearly all hard *(11).* Small spots of sandstone of Permian age crop out in the eastern part at low elevations. Most of the Edwards Plateau is strongly dissected. The Middle Concho River and its tributaries have cut deep valleys that have been partly refilled so that they have broad, flat floors. In some places, the valley fill material is believed to be more than

100 feet thick. South of Barnhart, there is a high, flat, undissected part of the Edwards Plateau. This is part of the Eldorado Divide, where drainage is to intermittent lakes and underground cavities. All other drainage is to the Concho River and then to the Colorado River. The highest elevation, 2,720 feet, is in the west-central part of the county on top of Ketchum Mountain. The lowest elevations, about 2,000 feet, are where the Middle Concho River and Spring Creek leave the county.

Natural Resources

The natural resources in Irion County that are the most important to the economy are the soils, oil and gas, water, and wildlife.

Most of the soils are in the Edwards Plateau Land Resource Area. Figure 3 shows their position in relation to the underlying material. A small part on the eastern side of the county is in the Rolling Plains Land Resource Area.

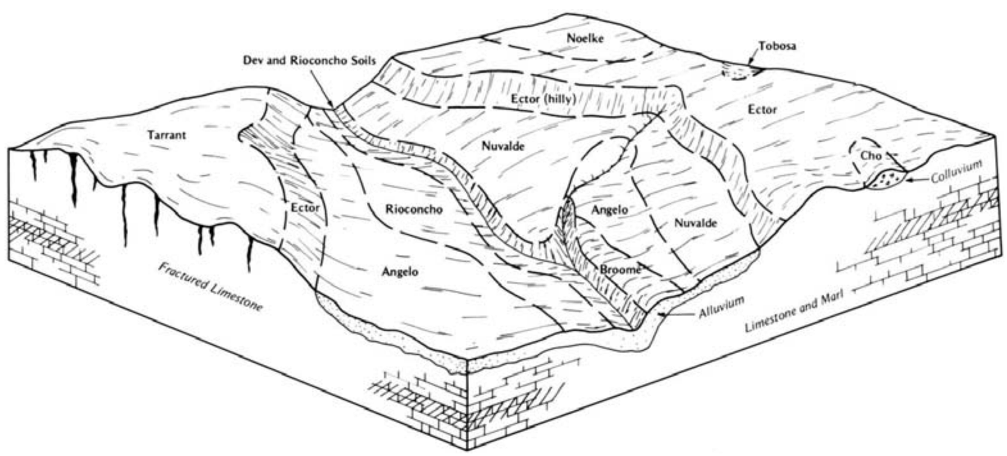

Figure 3.—Soils on the Edwards Plateau in Irion County.

About 33 percent of the county is prime farmland. These productive soils are the most suitable for prolonged cultivation without the risk of erosion. The rest of the soils are productive rangeland and are well suited to this use.

The petroleum industry is important to the economy, and there has been a considerable amount of drilling between 1975 and the present. In 1980, crude oil production was 3,125,342 barrels and natural gas production was 18,427,205 cubic feet.

Dove Creek, Spring Creek, and West Rocky Creek are all perennial streams, and the Middle Concho River has water most of the time. Except for West Rocky Creek, these streams come from springs in the county. West Rocky Creek has some springs a few miles north of the county. A few wells that yield enough water for irrigation have been dug near the Middle Concho River and near Dove Creek springs.

The flow of many springs can be increased by removing woody plants from the watershed, as is illustrated by the renewed flow of West Rocky Creek. In the early part of the 20th century, West Rocky Creek was a flowing stream. Between about 1915 and 1935, however, it gradually dried up. In the 1950's, about 70 percent of the mesquite was removed from the watershed, and the original prairie was restored. Springs reappeared in 1967, and now the flow is continuous and averages more than 1,000 gallons per minute.

Underground water of good quality in quantities adequate for home consumption and livestock use is present in nearly all parts of the county. A few wells have poor quality water, and finding water on a few ranches east of Barnhart has required drilling many times. Wells range in depth from 40 feet to 300 feet; the majority are less than 150 feet deep. A few wells are flowing wells.

On some ranches, hunting leases are an important source of income. White-tailed deer are most abundant in the southeastern part of the county, but some occur throughout. Turkey also occur throughout. Pronghorns are in huntable populations on a few ranches in the western part. Peccary, mourning dove, bobwhite quail, and scaled quail are also hunted.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed, and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Ector-Noelke

Very shallow and shallow, undulating to hilly, very gravelly, very cobbly and very stony loamy soils; on uplands

This map unit consists of gravelly, cobbly, and stony soils on limestone hills. Slopes range from 1 to 40 percent.

This map unit makes up 48 percent of the county. It is about 72 percent Ector soils, 15 percent Noelke soils, and 13 percent other soils.

Ector soils typically have a dark grayish brown very gravelly loam or very stony loam surface layer about 6 to 8 inches thick over underlying limestone bedrock.

Noelke soils typically have a grayish brown, very cobbly silty clay loam surface layer about 9 inches thick. From a depth of 9 to 12 inches is indurated laminated caliche, which rests on the underlying limestone bedrock.

Of minor extent in this map unit are Angelo, Conger, Nuvalde, and Tarrant soils. The Angelo and Nuvalde soils are deep soils in valleys or drainageways. The Conger soils are shallow loamy soils over a layer of indurated caliche. Tarrant soils are very shallow, very cobbly clay.

The soils in this unit are used as rangeland. Forage production from mid and short grasses is low because the soils are very shallow and droughty. The dominant woody plant is redberry juniper. These thin, rocky soils are not used as cropland.

Stones and bedrock limit excavating and grading for roads and building sites.

2. Angelo-Nuvalde

Deep, nearly level to gently sloping loamy soils; on uplands

This map unit consists of deep soils in valleys. Slopes range from 0 to 3 percent.

This map unit makes up 21 percent of the county. It is about 58 percent Angelo soils, 19 percent Nuvalde soils, and 23 percent other soils.

Angelo soils typically have a surface layer of grayish brown silty clay loam about 7 inches thick. From a depth of 7 to 36 inches is dark brown and brown silty clay. From a depth of 36 to 80 inches is pink silty clay with accumulations of carbonates.

Nuvalde soils typically have a surface layer of grayish brown and dark brown silty clay loam about 11 inches thick. The upper part of the subsoil is brown silty clay about 15 inches thick. The lower part of the subsoil from a depth of 26 to 48 inches is pink silty clay loam containing carbonates. The underlying material, to a depth of 80 inches, is pink silty clay loam.

Of minor extent in this map unit are Grandfield, Broome, Cho, Dev, Ector, Olton, Reagan, and Rioconcho soils. The Grandfield and Olton soils are noncalcareous, the Broome and Reagan soils are light colored, Cho soils are very shallow over hard caliche, Dev and Rioconcho are bottom land soils, and Ector soils are very shallow over limestone.

The soils in this unit are used mainly as rangeland. Mesquite is common in most areas. Mesquite is poor forage and uses much of the available soil moisture.

Most of the cropland and most of the prime farmland in the county are in this unit. Sorghums for grain or hay, cotton, wheat, oats, barley, and alfalfa are the main crops and grow well.

Dwellings and roads can be built on these soils but should be designed to overcome the shrink-swell potential and risk of corrosion.

3. Rioconcho-Angelo

Deep, nearly level to gently sloping loamy soils; on bottom lands and uplands

This map unit consists of deep soils on flood plains and valley floors. Slopes are 0 to 3 percent. Rioconcho soils are on flood plains, and Angelo soils are on valley floors.

This map unit makes up 10 percent of the county. It is about 37 percent Rioconcho soils, 33 percent Angelo soils, and 30 percent other soils.

Rioconcho soils typically have a grayish brown, silty clay loam surface layer about 24 inches thick. From a depth of 24 to 40 inches is brown silty clay. Below this, to a depth of more than 80 inches, is pale brown silty clay.

Angelo soils typically have a grayish brown silty clay loam surface layer about 7 inches thick. From a depth of 7 to 36 inches is dark brown and brown silty clay. From a depth of 36 to 80 inches is pink silty clay with accumulations of calcium carbonates.

Of minor extent in this map unit are Broome, Cho, Dev, Mereta, and Nuvalde soils. The Broome soils are deep, light-colored silty clay loam. Cho soils are very shallow over caliche, Mereta soils are shallow over hard caliche, Dev soils are very gravelly soils on bottom lands, and Nuvalde soils are deep soils on valley floors.

All the acreage of this unit is used as rangeland. The Rioconcho soils produce more forage than the Angelo soils. Mesquite is common. It produces poor forage and uses much of the available soil moisture.

Rioconcho and Angelo soils are suited to crops. Sorghums for grain and hay, cotton, wheat, oats, barley, and alfalfa are the main crops. Pecan trees grow along many of the stream channels. Many more pecans could be grown, but irrigation is needed if the trees grow away from the streams. Angelo soils are prime farmland soils and should be preserved for food and fiber production.

Dwellings and other permanent structures should not be built on the Rioconcho soils because of the flood hazard, but they can be built on the Angelo soils if designed to overcome the shrink-swell potential and the risk of corrosion.

4. Cho-Mereta

Very shallow and shallow, nearly level to undulating, gravelly and loamy soils; on uplands

This map unit typically is at intermediate elevations, on foot slopes, or on knolls.

This map unit makes up 9 percent of the county. It is 41 percent Cho soils, 22 percent Mereta soils, and 37 percent other soils.

Cho soils have a dark grayish brown gravelly loam surface layer 8 inches thick over a 10-inch layer of indurated caliche. Below this, to a depth of 80 inches, the underlying material is gravelly caliche.

Mereta soils have a brown clay loam surface layer about 16 inches thick. From a depth of 16 to 30 inches is indurated platy caliche. The underlying material, to a depth of 80 inches, is weakly cemented caliche.

Of minor extent in this map unit are Angelo, Blakeney, Broome, Conger, Nuvalde, Reagan, and Spade soils. The Angelo and Nuvalde soils are deep soils in valleys or drainageways. Broome and Reagan soils are deep, light-colored silty clay loam. Conger soils are shallow loam over hard caliche. Blakeney and Spade soils are shallow to moderately deep fine sandy loam.

The soils in this unit are mainly used as rangeland. The forage productivity of the Cho soils is low and of the Mereta soils is medium. Mesquite and a variety of shrubs grow on these soils. Brush control is a major expense to ranchers. The shrubs provide browse and cover for a wide variety of wildlife.

Cho soils are too shallow for cultivation. The Mereta soils can be used for crops, such as wheat, oats, or forage crops that grow during the cool season and in spring.

Dwellings and roads can be built on these soils, but the very shallow and shallow depth over indurated caliche and the slope of the Cho soils should be considered in designing dwellings and installing roads. The underlying caliche material is a good foundation for buildings and roads. Septic tank filter fields work well after the indurated caliche is broken up or removed.

5. Conger-Reagan-Broome

Shallow and deep, nearly level to gently sloping loamy soils; on uplands

This map unit consists of light-colored calcareous soils in the western part of the county. The slopes are mainly 0 to 3 percent.

This map unit makes up 7 percent of the county. It is about 55 percent Conger soils, 15 percent Reagan soils, 10 percent Broome soils, and 20 percent other soils.

Conger soils typically have a brown loam surface layer about 6 inches thick. The subsoil is calcareous brown clay loam about 11 inches thick. Below this is an indurated caliche layer about 5 inches thick. The substratum, to a depth of 72 inches, is pink, soft caliche.

Reagan soils typically have a surface layer of calcareous, pale brown and brown silty clay loam about 8 inches thick. The subsoil, from a depth of 8 to 36 inches, is light brown silty clay loam. From a depth of 36 to 80 inches is pink silty clay loam with accumulations of calcium carbonate.

Broome soils typically have a light yellowish brown silt loam surface layer about 6 inches thick. The subsoil, from a depth of 6 to 19 inches, is light brown silty clay loam. From a depth of 19 to 80 inches, the subsoil is pink silty clay loam with accumulations of calcium carbonate.

Of minor extent in this map unit are Angelo, Mereta, Nuvalde, and Tobosa soils. The Mereta soils are shallow clay loam over hard caliche. The Angelo and Nuvalde soils are deep silty clay loam and typically are in drainageways. The Tobosa soils are deep clay in concave areas.

All the soils in this unit are used as rangeland. Production of mid and short grasses is low on Conger soils and moderate on Broome and Reagan soils. Mesquite is common on the Broome and Reagan soils.

Conger soils are too droughty to be used as cropland. Reagan soils are suited to cultivation when irrigated. Sorghums, cotton, and small grains are the main crops when the Broome soils are irrigated or dryfarmed.

Dwellings and roads can be easily built and maintained on these soils when designed and built to overcome the moderate shrink-swell potential of Broome and Reagan soils. Septic tank filter fields work well in the Broome and Reagan soils and also in the Conger soils after the indurated caliche layer is broken up or removed. These soils will corrode uncoated steel pipe.

6. Tarrant

Very shallow and shallow, undulating, very cobbly clayey soils; on uplands

This map unit consists of very cobbly clayey soils on limestone hills. Slopes range from 1 to 8 percent.

This map unit makes up 5 percent of the county. The Tarrant soils make up 70 percent of the map unit; other soils make up 30 percent.

Tarrant soils have a dark gray and dark grayish brown, very cobbly clay surface layer about 12 inches thick over hard, coarsely fractured limestone bedrock.

Of minor extent in this map unit are Angelo, Ector, and Nuvalde soils. The Angelo and Nuvalde soils are deep loamy soils in small valleys or drainageways. The Ector soils are very gravelly or stony loam with slopes of 1 to 40 percent.

The soils in this unit are used as rangeland. Forage production of mid and short grasses is moderate, but the vegetation includes a variety of evergreens. The typical woody vegetation is live oak trees mixed with juniper and shrubs. The plant growth on this unit provides good deer habitat. These thin, rocky soils are not used as cropland.

Stones and bedrock limit excavating and grading for roads and building sites.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

The scale on the detailed soil maps is 1:31,680. This is 2,640 feet per inch, 2 inches per mile, or 160 acres per square inch. In the metric system, 1 millimeter is 31.680 meters and 1 square centimeter is 10.036 hectares.

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Broome silt loam, 0 to 1 percent slopes, is one of several phases in the Broome series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Mereta-Nuvalde complex, 0 to 1 percent slopes, is an example.

A *soil association is* made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Rioconcho-Dev association, frequently flooded, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Blakeney and Spade fine sandy loams, undulating, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

AnA—Angelo silty clay loam, 0 to 1 percent slopes. This deep, nearly level soil is above overflow but occurs in valleys as long, narrow strips parallel to streams. Areas range from 10 to 600 acres.

Typically, the surface layer is dark grayish brown silty clay loam 7 inches thick over dark brown silty clay 11 inches thick. The next layer is brown silty clay about 18 inches thick. Between depths of 36 and 80 inches is pink silty clay, of which 10 percent is visible calcium carbonate in small soft masses and concretions (fig. 4).

Runoff is slow. Permeability is moderately slow, and the available water capacity is high. Shrinking or swelling as moisture content changes is moderately high. The hazard of water erosion is slight, and that of soil blowing is slight.

Included with this soil in mapping are small areas of Dev, Nuvalde, and Rioconcho soils and the more sloping Angelo soils. These included soils make up 20 percent of the mapped areas.

Nearly all of this Angelo soil is rangeland. Most areas receive and absorb some runoff from adjacent hills, thus partly offsetting the low rainfall. Controlling mesquite and maintaining adequate plant cover are the main management concerns.

About 80 percent of this soil could be converted to cropland, but only about 1,000 acres is now used for wheat, grain sorghum, and cotton. In some places, this soil is in narrow strips and irregular shapes or has too many drainageways to be used as cropland. Keeping crop residue on the surface helps to reduce evaporation, soil temperature, runoff, and erosion. Terraces between the cropland and higher lying, more sloping soils are necessary to prevent gullying in some places.

Dwellings and roads can be built on this soil but should be designed to withstand the shrink-swell potential and risk of corrosion. Also, septic tank absorption fields should be constructed to overcome the moderately slow permeability of the soil.

The capability subclass is IIIc nonirrigated and class I irrigated; the range site is Clay Loam.

AnB—Angelo silty clay loam, 1 to 3 percent slopes. This deep, gently sloping soil is above overflow, but it occurs in valleys as long narrow strips parallel to streams. Slopes average 1.5 percent. Areas range from 20 to 800 acres.

The surface layer is dark grayish brown silty clay loam about 12 inches thick. The next layer is brown clay about 24 inches thick. Between depths of 36 and 80 inches is pink silty clay loam, about 70 percent of which is white calcium carbonate masses. The lower part of this layer is slightly redder than the upper part. In some places rounded limestone gravel is below a depth of 40 inches.

Runoff is medium. Permeability is moderately slow, and the available water capacity is high. Shrinking or swelling as moisture content changes is moderately high. The hazard of water erosion is moderate, and the hazard of soil blowing is slight.

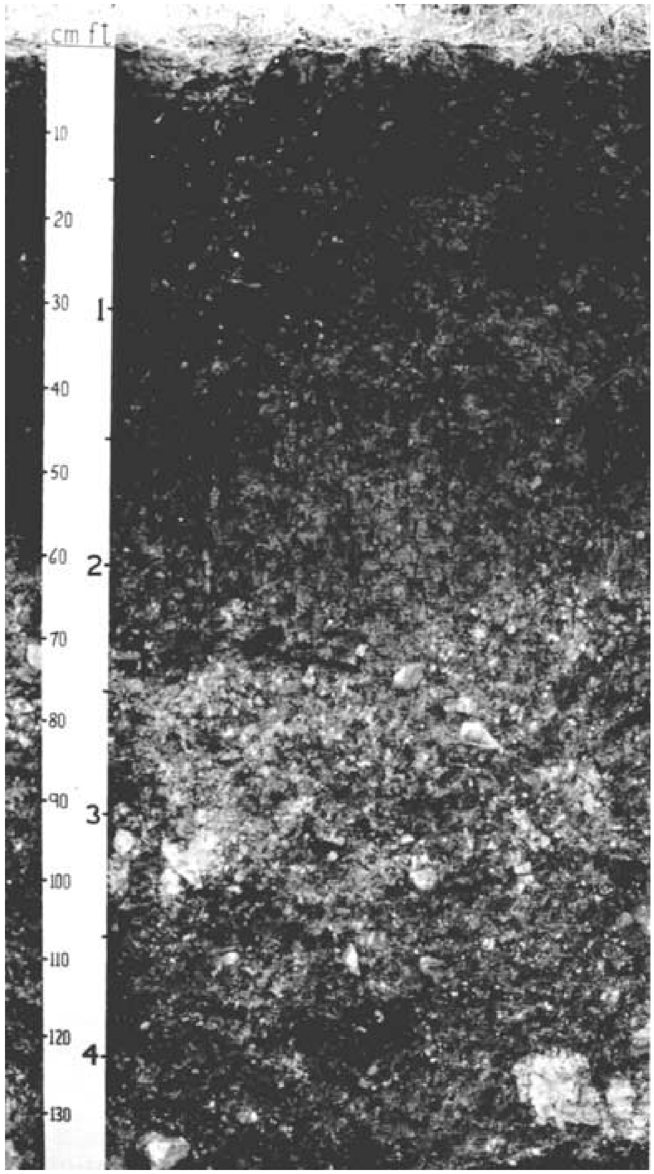

Figure 4.—Profile of Angelo silty clay loam, 0 to 1 percent slopes. The zone of calcium carbonate accumulation begins at a depth of 26 to 30 inches.

Included with this soil in mapping are small areas of Broome, Dev, Nuvalde, and Rioconcho soils. The included soils make up less than 10 percent of the total acreage. Also included are some less sloping areas of Angelo soil, making up as much as 50 percent of some areas, but too narrow to be mapped separately.

Most of this Angelo soil is used as rangeland. Most areas receive and absorb some runoff from adjacent hills, thus partly offsetting the low rainfall. Controlling mesquite and maintaining adequate plant cover are the main management concerns.

Only a small percentage of this soil is used as cropland. About one-fourth would be good cropland areas. The other three-fourths is in narrow strips or isolated small spots or has too many drainageways to be suited to crops.

If this soil is used as cropland, keeping crop residue on the surface helps protect the soil from water erosion and soil blowing and helps conserve moisture. Terraces are needed to slow and reduce water runoff and prevent water erosion. They are also helpful in conserving moisture. All tillage should be on the contour because of the hazard of water erosion.

Dwellings and roads can be built on this soil but should be designed to withstand the shrink-swell potential and risk of corrosion. Also, septic tank absorption fields should be constructed to overcome the moderately slow permeability.

The capability subclass is IIIe nonirrigated and IIe irrigated; the range site is Clay Loam.

BPC—Blakeney and Spade fine sandy loams, undulating. These shallow to moderately deep, gently sloping to sloping soils formed in materials weathered from fine grained sandstone and loamy materials. Typically, they are at the gently sloping base of steeper limestone hills or on knolls at the edge of broad valleys (fig. 5). The slopes range from 1 to 8 percent but generally are 1 to 5 percent. Areas are irregular in shape and range from 5 to 40 acres.

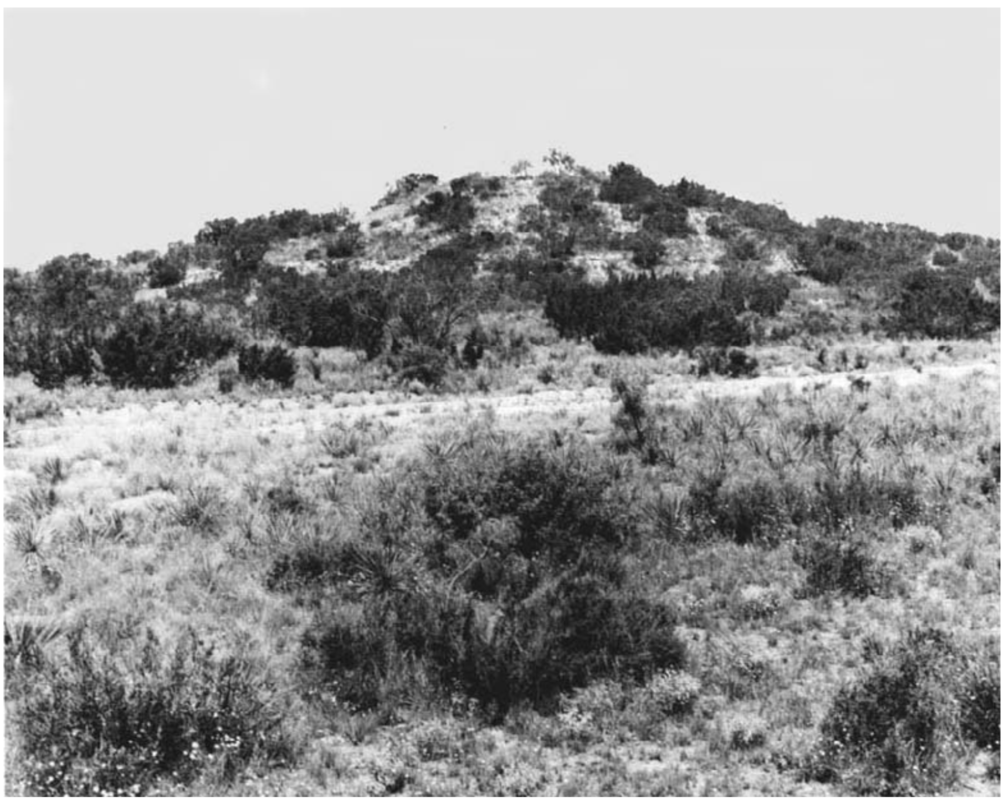

Figure 5.—Blakeney and Spade fine sandy loams, undulating, are in the foreground. Yucca is typical of this Sandy Loam range site.

The soils in this map unit are unusually variable; however, the surface layer is fine sandy loam in most places, and the rooting depth is shallow to moderately deep. The use and management of the soils in this unit are similar.

About 45 percent of this unit is Blakeney and closely similar soils and 30 percent is Spade and closely similar soils. The rest of the unit is 2 percent Olton soils; 11 percent soils similar to Grandfield soils; 3 percent shallow and noncalcareous soils; 2 percent dark soils; and 7 percent soils with more than 40 percent calcium carbonate.

The Blakeney soils have a surface layer of brown, calcareous fine sandy loam 7 inches thick. The subsoil is pale brown, calcareous fine sandy loam about 7 inches thick. Between depths of 14 and 16 inches is continuous, pinkish white, indurated caliche. The underlying material to a depth of 80 inches is moderately to weakly cemented caliche containing calcium carbonates that diminish with depth.

The Blakeney soils are well drained, and surface runoff is medium. Permeability is moderately rapid, and the available water capacity is low. The root zone is shallow but easily penetrated by roots. The hazard of water erosion is severe, and the hazard of soil blowing is moderate.

The Spade soils have a surface layer that is calcareous, pale brown fine sandy loam about 11 inches thick. The subsoil is very pale brown fine sandy loam about 19 inches thick. Weathered sandstone containing accumulations of calcium carbonate is between depths of 30 and 36 inches. The underlying material, to a depth of 80 inches, is fine grained, pale yellow, calcareous sandstone.

Surface runoff is medium in the Spade soils. Permeability is moderately rapid. The available water capacity is low. The root zone is moderately deep and is easily penetrated by roots. The hazards of water erosion and soil blowing are moderate.

All the soils in this unit are used as rangeland. Controlling mesquite and redberry juniper and maintaining an adequate plant cover are the main management concerns. These soils are not suited to cropland because the areas are small and the shallower parts are droughty.

If the soil is prepared for roads or building sites, the depth to rock or a cemented pan is a concern. Excavations may be difficult, and the underlying sandstone or caliche is a concern in septic tank filter fields.

The Blakeney soil is in capability subclass VIe and the Shallow range site. The Spade soil is in capability subclass VIe and the Sandy Loam range site.

BrA—Broome silt loam, 0 to 1 percent slopes. This deep, nearly level soil is adjacent to but higher than flood plains. Areas are irregular in shape and range from 10 to 60 acres.

The surface layer is pale brown silt loam about 8 inches thick. The next layer is light yellowish brown silty clay loam about 16 inches thick. Between depths of 24 and 44 inches is pink silty clay loam with accumulations of calcium carbonate (fig. 6). From a depth of 44 to 60inches is pink silty clay loam with some rounded limestone gravel.

Surface runoff is slow. Permeability is moderate, and the available water capacity is high. The root zone is deep, and the soil is easily penetrated by roots. The hazard of water erosion is slight, and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of more sloping Broome and Nuvalde soils. These included soils make up less than 10 percent of the total acreage.

In most areas this Broome soil is used as rangeland. Most areas of this soil receive runoff from adjacent higher soils, thus partly offsetting the low rainfall. Controlling mesquite and maintaining adequate plant cover are the main management concerns. Mesquite is not quite as abundant on this soil as it is on less limy soils.

If this soil is used as cropland, keeping crop residue on the surface helps protect the soil from erosion, high temperature, and high evaporation losses. Terraces are helpful in conserving moisture. Because of the calcium carbonate content, sorghum crops and some ornamental plants sometimes develop iron deficiencies. The soil is friable and easily tilled throughout a wide range in moisture content. On irrigated areas, phosphate fertilizer should be pelleted or placed in bands to avoid its tie-up with the calcium in the soil.

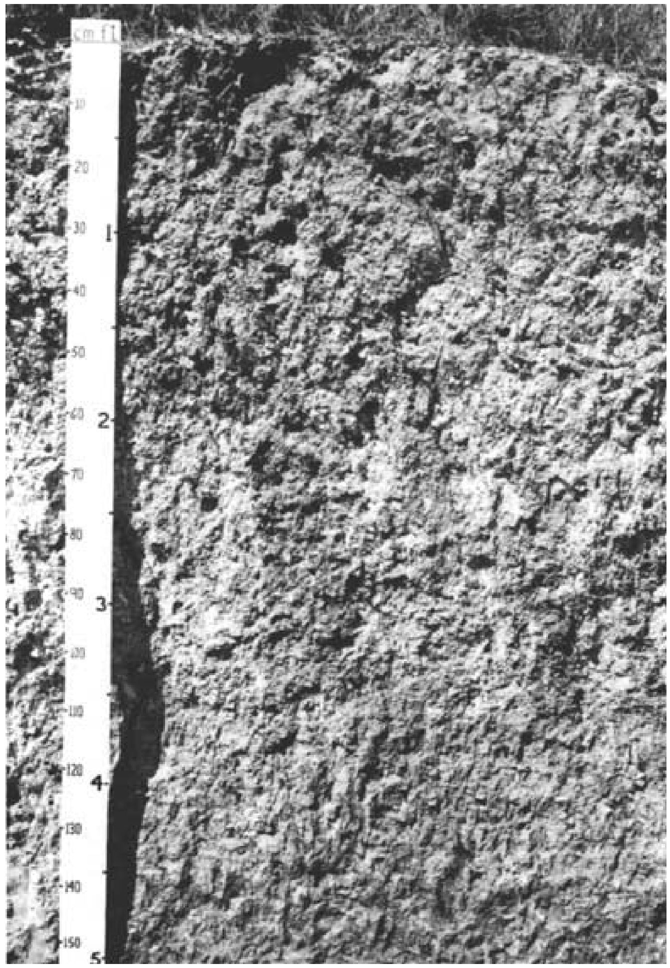

Figure 6.—Profile of Broome silt loam, 0 to 1 percent slopes. The calcium carbonate accumulation is barely visible.

Septic tank absorption fields work well in this soil. Roads and dwellings can be designed to overcome the shrink-swell potential of the soil.

The capability subclass is IIc nonirrigated and class I irrigated; the range site is Loamy.

BrB—Broome silt loam, 1 to 3 percent slopes. This deep, well drained soil is most commonly on convex, gentle slopes in long, narrow areas between darker, more clayey soils and flooded bottom lands. A few areas are on low knolls. Mapped areas range from 5 to 100 acres.

Typically, the surface layer is light yellowish brown silt loam about 5 inches thick. The subsoil is more than 55 inches thick. It is light brown silt loam from a depth of 5 to 13 inches, light brown and pink silty clay loam from a depth of 13 to 30 inches, and pink silty clay loam from a depth of 30 to 90 inches. An accumulation of white calcium carbonate, which is diffused, in soft masses, or in concretions, is below a depth of 19 inches.

Water and air move through this soil at a moderate rate, and surface runoff is medium. The available water capacity is high. Because of the calcium carbonate content, sorghum crops and some ornamental plants sometimes develop iron deficiencies. The surface layer is friable and easily tilled throughout a fairly wide range in moisture content. Thin platy surface crusts form on both cropland and rangeland when the soil is bare. On irrigated areas, phosphate fertilizer should be pelleted or placed in bands to avoid its tie-up with the calcium in the soil.

Included in mapping are small areas of Nuvalde and Reagan soils. Also included are small areas of more sloping Broome soils. The included soils each make up about 5 percent of the total acreage.

Nearly all of this Broome soil is rangeland. Most areas receive some runoff from adjacent higher soils, thus partly offsetting the low rainfall. Controlling mesquite and maintaining adequate plant cover are the main management concerns. Mesquite is not quite as abundant on this soil as it is on less limy soils.

A small acreage is cropland, and sorghums, small grains, and cotton are grown. Crop residue should be left on the surface to reduce evaporation, soil temperature, soil blowing, and water erosion. Terraces are needed to reduce erosion and conserve water. All tillage should be on the contour to reduce the speed of runoff.

Septic tank absorption fields work well on this soil. Roads and dwellings can be designed to overcome the shrink-swell potential of the soil.

The capability subclass is IIIe nonirrigated and IIe irrigated; the range site is Loamy.

BrC—Broome silt loam, 3 to 5 percent slopes. This deep, gently sloping soil is adjacent to but higher than flood plains. Areas are irregular in shape and range from 10 to 50 acres.

The surface layer is grayish brown silt loam 12 inches thick. The next layer is light brownish gray silty clay loam 8 inches thick. Between depths of 20 and 60 inches is pale brown silty clay loam that is about 20 percent visible calcium carbonate.

Permeability is moderate, and the available water capacity is high. The root zone is deep, and the soil is easily penetrated by roots. The hazard of water erosion is high, and the hazard of soil blowing is slight.

Included with this soil in mapping are small areas of less sloping Broome, Conger, and Nuvalde soils. The included soils make up 10 percent of the total acreage.

All the acreage of this soil is used as rangeland. Most areas receive some runoff from adjacent, higher soils, thus partly offsetting the low rainfall. Controlling mesquite and maintaining adequate plant cover are the main management concerns. On this soil, mesquite is not quite as abundant as it is on less limy soils.

This Broome soil is not used as cropland. The hazard of water erosion is so great that only close-spaced crops that produce much residue should be grown. Terraces and contour tillage to slow runoff are also needed to reduce soil erosion.

Septic tank absorption fields work well in this soil. Roads and dwellings can be designed to overcome the shrink-swell potential of the soil.

The capability subclass is IVe nonirrigated and IIIe irrigated; the range site is Loamy.

CHB—Cho gravelly loam, undulating. This very shallow and shallow soil has slopes that are convex and range from 2 to 8 percent. Drainageways are narrow. Areas are irregular and range from 5 to 1,000 acres. A closely related soil that is more than 35 percent by volume coarse fragments makes up 40 percent of the total acreage.

Typically, the soil is dark grayish brown gravelly loam 8 inches thick over indurated caliche. The indurated caliche is about 10 inches thick, and below this is softer gravelly caliche (fig. 7).

Water and air move through this soil at a moderate rate, and surface runoff is medium. The available water capacity is very low because of the very shallow soil depth and the content of coarse fragments. The erosion hazard is moderate on bare rangeland.

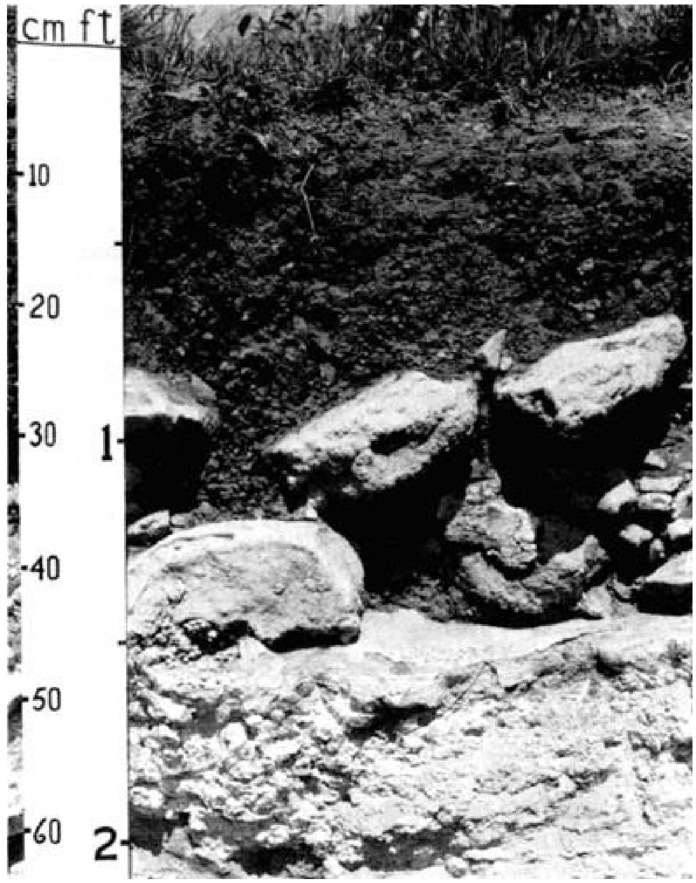

Figure 7.—Profile of Cho gravelly loam, undulating. At a depth of 18 inches, the indurated caliche is continuous and restricts root movement.

Included with this Cho soil in mapping are small areas of Conger and Mereta soils and a deeper soil without indurated caliche layers. Combined, the Mereta and Conger soils are 5 percent of the total acreage, and the deeper soil is 10 percent.

All areas of this Cho soil are rangeland, but the production is low. The potential plant community is a short-grass prairie with a few mid grasses. The main management concerns are controlling woody plants, such as mesquite and redberry juniper, and maintaining a vigorous plant cover.

This soil is not used as cropland because of the slope, the very low available water capacity, the very shallow root zone, and the erosion hazard.

If the soil is prepared for building roads or dwellings, the indurated caliche (cemented pan) must be considered. The indurated caliche layer makes excavation difficult, the percolation rate through the indurated layer very slow, and land leveling difficult. Septic tank filter fields must be placed below the indurated layer. The underlying caliche is well suited to roadbuilding, and most of the caliche pits in the county are in Cho soil areas.

This soil is in capability subclass VIs; the range site is Very Shallow.

CnA—Conger loam, 0 to 3 percent slopes. This shallow soil occurs on foot slopes of limestone hills, as nearly level tops on limestone hills, and in a few places as knolls on outwash plains. Areas range from 5 to 1,000 acres.

Typically, this soil has a surface layer of calcareous, friable, brown loam 6 inches thick. The subsoil is calcareous brown clay loam 11 inches thick. Below this is an indurated caliche layer 5 inches thick. The substratum is pink soft caliche. A few pebbles could be in any layer or on the surface (fig. 8).

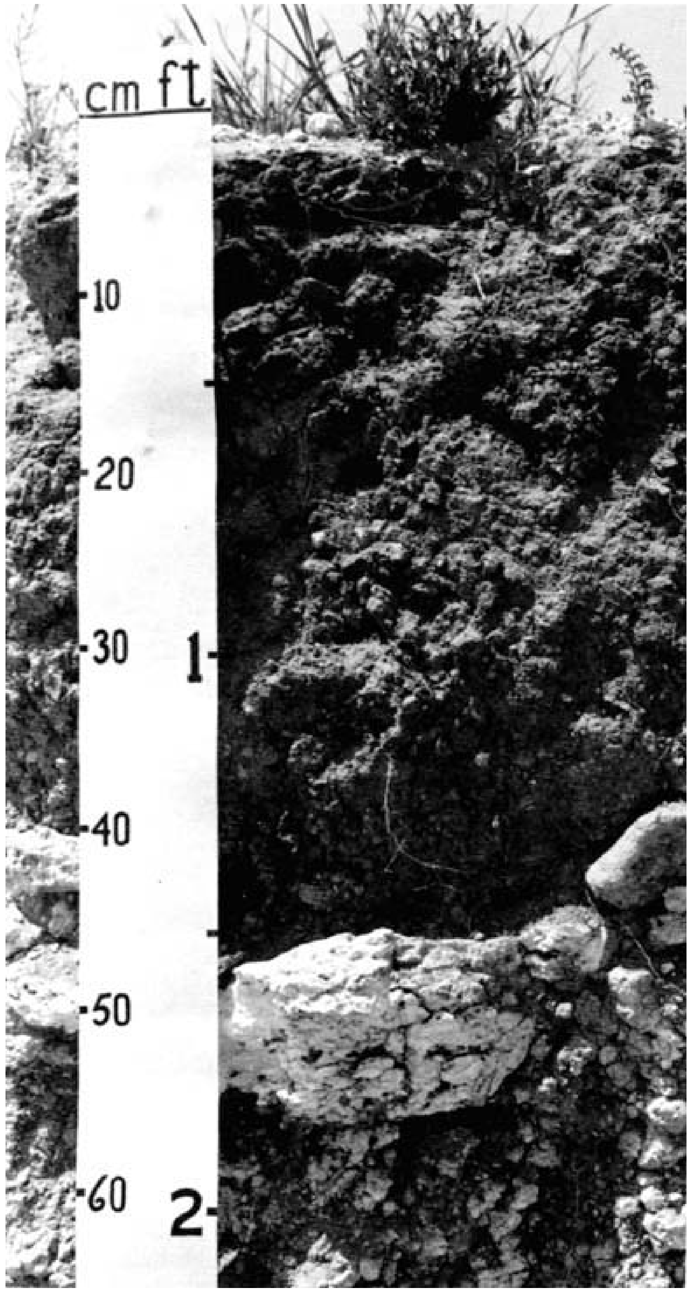

Figure 8.—Profile of Conger loam, 0 to 3 percent slopes.

Water and air move through this soil at a moderate rate, and surface runoff is medium. The available water capacity is low because the indurated caliche layer at a depth of about 17 inches restricts the downward movement of water.

This unit is about 75 percent Conger loam and closely similar soils. Included in mapping are areas of Cho and Mereta soils that make up 5 percent of the unit, areas of Broome soils that make up 10 percent of the unit, and areas of a soil that is similar to the Reagan soil but is shallow over caliche that makes up 10 percent of the unit.

All of this Conger soil is used as rangeland. The low rainfall, medium runoff, low available water capacity, and the shallow rooting depth make this soil droughty and limit the amount of forage produced. The main management concerns are controlling mesquite and redberry juniper and maintaining a vigorous plant cover.

This shallow soil is not used as cropland.

The Conger soil is not suitable for use as septic tank filter fields unless the indurated caliche layer is removed. After the indurated layer is removed, the filter fields work well. The indurated caliche layer also makes shallow excavations difficult and therefore interferes with the construction of foundations for roads and small buildings.

This soil is in capability subclass VIe; the range site is Shallow.

EGB—Ector very gravelly loam, undulating. This very shallow and shallow soil is on low hills. Slopes range from 1 to 8 percent. The areas are irregular and large and range from 20 to more than 2,000 acres.

Typically, the soil material is dark grayish brown very gravelly loam 6 inches thick. Sixty-five percent is limestone and hard caliche fragments. Some soil extends to a depth of 12 inches in narrow cracks or between plates. Below this is limestone that has caliche as coatings and in cracks.

Air and water move through this soil at a moderate rate. Because of the slope, runoff is rapid. The available water capacity is very low because of the large percentage of coarse fragments and shallow and very shallow soil depth. Below a depth of 12 inches, root development is restricted by the underlying limestone. The coarse fragments on the surface help slow runoff and reduce erosion. Plants on this soil benefit from small rains because the fragments concentrate the water in the soil between the fragments.

Included with this soil in mapping are small areas of Conger and Cho soils, each making up about 5 percent of the total acreage. Rock outcrops that are bare of vegetation are less than 1 percent of the total acreage.

Ector soil is used as rangeland. The typical woody vegetation is juniper and several species of shrubs. Live oak trees do not grow on this soil because cracks in the underlying limestone are sealed with caliche. Removing juniper and maintaining adequate plant cover to reduce runoff, soil temperature, evaporation, and erosion are the main management problems.

Ector soils are not used for crops because of the erosion hazard, many coarse fragments, and very shallow to shallow depth.

Stones and bedrock limit excavating and grading for roads and building sites. Septic tank filter fields should be placed in fill material. Some of the limestone could be crushed for road-surfacing material.

This soil is in capability subclass VIIs; the range site is Limestone Hill.

ESE—Ector very stony loam, hilly. This very shallow and shallow, very stony soil is on limestone hills. The slopes range from 8 to about 40 percent but are mostly less than 25 percent. The areas are irregular and range from 10 to more than 2,000 acres.

Typically, the soil is about 8 inches thick and consists of dark grayish brown very stony loam. Between depths of 8 and 15 inches, some soil is in the narrow cracks or between the limestone plates, which have caliche coatings that seal the cracks. Below this is coarsely fractured limestone.

Air and water move through this soil at a moderate rate. Because of the slope, runoff is rapid. The available water capacity is very low because of the large percentage of limestone fragments and very shallow and shallow depth. Below a depth of 8 inches, root development is limited because of the caliche that coats and seals the underlying limestone. Limestone fragments on the surface help slow runoff and reduce erosion. Plants on these soils benefit from small rains because the limestone fragments concentrate the water into the soil between the fragments, moistening the soil to a greater depth.

Included with this soil in mapping are small areas of Conger, Cho, and the less sloping and more sloping Ector soils. These make up about 5 percent of the total acreage. Also included is a shallow soil over marl, which is about 5 percent of the acreage. About 5 percent is Rock outcrop, which is nearly barren, with plants growing only in cracks. Some areas have a surface layer of very gravelly loam or very cobbly loam.

This Ector soil is used as rangeland. The typical woody vegetation is juniper and several species of shrubs. Juniper has increased on some areas, improving the deer habitat, but some juniper could be removed to increase forage for livestock. Live oak trees do not grow on this soil because cracks in the underlying limestone are sealed with caliche (fig. 9). Removing juniper and maintaining adequate plant cover to reduce runoff, soil temperature, evaporation, and erosion are the main management problems.

Figure 9.—Ector soil has been washed away, exposing the indurated caliche that seals the cracks in the underlying limestone.

This soil is not used for crops because of the erosion hazard, many coarse fragments, and shallow and very shallow soil depth.

The steep slope, stones on the surface, shallowness over bedrock, and risk of corrosion to uncoated steel are limiting features to be considered when selecting road and building sites. Some of the underlying limestone could be crushed for road-surfacing material.

This soil is in capability subclass VIIs and the Steep Rocky range site.

GfB—Grandfield fine sandy loam, 1 to 5 percent slopes. This deep, gently sloping soil is on hillsides or near the base of much steeper limestone hills. Areas are 5 to 60 acres.

Typically, this soil has a surface layer that is brown fine sandy loam 9 inches thick. It is noncalcareous and mildly alkaline. The subsoil extends to a depth of 56 inches. From a depth of 9 to 17 inches, it is noncalcareous, reddish brown sandy clay loam. From a depth of 17 to 35 inches, it is yellowish red, calcareous sandy clay loam. From a depth of 35 to 56 inches, it is pink fine sandy loam that has a distinct calcium carbonate accumulation. The underlying material, to a depth of 80 inches, is loamy slope colluvium or soft sandstone.

Water and air move through this soil at a moderate rate. Surface runoff is slow. The available water capacity is medium. The surface layer is friable and easily tilled throughout a wide range in moisture content. Hazards of soil blowing and water erosion are high when the soil is bare.

This unit is about 70 percent Grandfield and closely similar soils and 30 percent other soils. The soils that are closely similar to this soil are one that has a darkened surface layer, another that has sandstone at a depth of 20 to 40 inches, and another that has hard caliche at a depth of 20 to 40 inches. Also included are one soil that has hard caliche at a depth of 14 to 20 inches and small areas of Olton soils. Also included are about 100 acres of a soil that has a loamy fine sand surface layer and about 90 acres that formerly was cropland and is now moderately eroded.

On cropland, continuous plant cover is important in controlling soil blowing and water erosion. Controlling mesquite is also beneficial.

All areas of Grandfield soil are now rangeland. Some of these soils were cropland, but soil blowing and water erosion contributed to many crop failures. Erosion can be controlled so that this soil can be used for cropland.

Fertilizers are needed in irrigated areas and also after prolonged dryland cropping. The hazards of soil blowing and water erosion are both moderately severe so that stripcropping, minimum tillage, crop residue on the surface, and addition of manure are all helpful and in some areas essential.

Dwellings, roads, and septic tank absorption fields are easily built and maintained on this soil.

This soil is in capability subclass IIIe nonirrigated and IIIe irrigated; the range site is Sandy Prairie.

MnA—Mereta-Nuvalde complex, 0 to 1 percent slopes. These shallow and deep soils are on nearly level ridges and in broad flat valleys. Areas are irregular and range from 5 to 650 acres.

Mereta and closely similar soils make up about 65 percent of this map unit, ranging from 60 to 90 percent; Nuvalde soils make up about 20 percent, ranging from 10 to 30 percent; and Angelo, Cho, and Conger soils make up about 15 percent. The soils closely similar to Mereta soils are one that is more than 20 inches deep over hard caliche, one that is less clayey, and another that is a shallow clayey soil. Areas of these soils are so intricately mixed or so small in size that they cannot be shown separately at the scale used in mapping.

The Mereta soils have a surface layer that is brown clay loam about 16 inches thick over indurated caliche (fig. 10). The indurated platy caliche layer is 14 inches thick. The underlying material from a depth of 30 to 80 inches is weakly cemented caliche.

Water and air move through Mereta soils at a moderately slow rate, and surface runoff is slow. The available water capacity is low. Because an indurated caliche layer occurs at a depth of 14 to 20 inches, the root zone is shallow. The hazard of water erosion is slight, and the hazard of soil blowing is moderate.

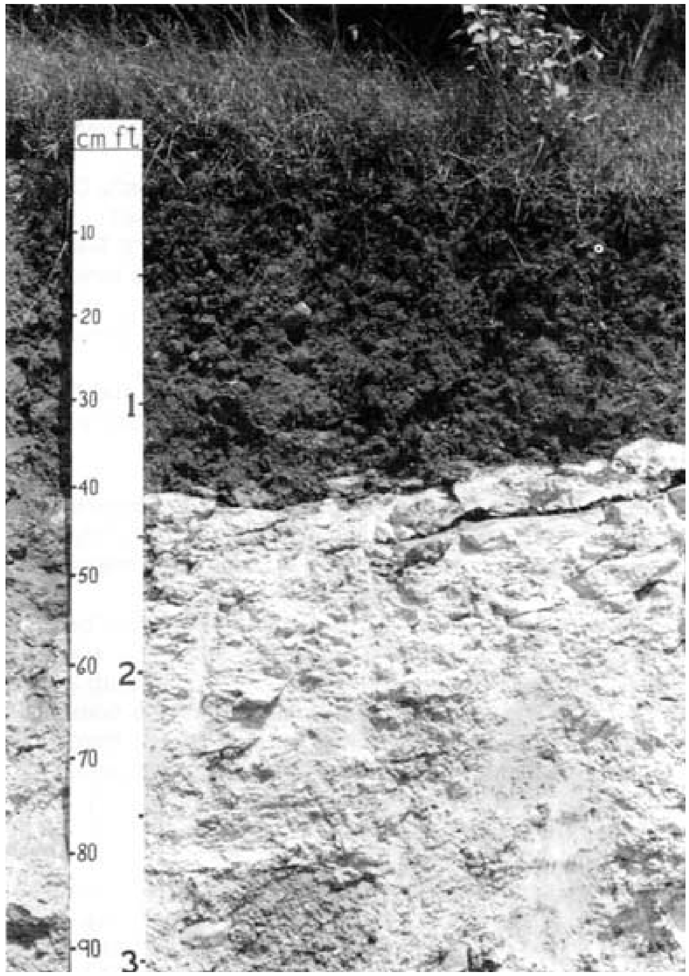

Figure 10.—Profile of a Mereta soil in an area of Mereta-Nuvalde complex, 0 to 1 percent slopes.

The Nuvalde soils have a surface layer that is brown clay loam 14 inches thick. The subsoil between depths of 14 and 27 inches is light brown clay loam. Between depths of 27 and 48 inches, it is pink silty clay loam high in calcium carbonate. The underlying material from a depth of 48 to 80 inches is loamy caliche.

Water and air move through the Nuvalde soils at a moderate rate, and surface runoff is slow. The available water capacity is high. The hazard of water erosion is low, and the hazard of soil blowing is moderate.

Most of these soils are rangeland. The main management concerns are controlling mesquite and keeping a vigorous plant cover on the soil to reduce runoff, evaporation, and erosion.

These soils are not used for cropland because there are thin spots. The cemented layer in the Mereta soils is undulating beneath the soil surface. In small spots, it is close to the surface and would be plowed up if it were cultivated. In spots, a limestone ledge 4 to 6 inches thick is also a hindrance to cultivation.

Dwellings and roads can be built on these soils but should be designed to withstand the shrink-swell potential of the soils. The caliche underlying the Mereta soils is good road construction material. Septic tank absorption fields may fail in these soils unless constructed to overcome the soil permeability. Steel pipes should be protected from corrosion.

The Mereta soil is in capability subclass IIIs and the Shallow range site. The Nuvalde soil is in capability subclass IIc and the Clay Loam range site.

MnB—Mereta-Nuvalde complex, 1 to 3 percent slopes. These are shallow and deep soils on gently sloping ridges and in broad valleys. Areas are irregular and range from 10 to 600 acres.

This complex is about 60 percent Mereta and closely similar soils and 20 percent Nuvalde soils. Other soils, mostly Angelo, Conger, and Noelke soils, make up about 20 percent. The soils that are similar to Mereta soils are one that is less clayey, one that is underlain by hard caliche at a depth of more than 20 inches, and another that is shallow and clayey. Areas of these soils are so intricately mixed that to separate them at the scale used in mapping was not practical.

The surface layer of Mereta soils is grayish brown and brown clay loam about 14 inches thick. From a depth of 14 to 24 inches is indurated caliche that is laminar and platy in the upper few inches. From a depth of 24 to 40 inches is gravelly caliche.

Water and air move through the Mereta soils at a moderate rate, and surface runoff is slow. The available water capacity is low. Because an indurated caliche layer occurs at a depth of 14 to 20 inches, the root zone is shallow. The hazards of water erosion and soil blowing are moderate.

The surface layer of Nuvalde soils is grayish brown clay loam about 11 inches thick. The subsoil between depths of 11 and 42 inches is pale brown clay loam. From a depth of 42 to 60 inches, the subsoil is very pale brown silty clay loam with accumulations of calcium carbonate. From a depth of 60 to 65 inches is soft gravelly caliche.

Water and air move through the Nuvalde soils at a moderate rate, and surface runoff is slow. The available water capacity is high. The hazards of water erosion and soil blowing are moderate.

Nearly all the acreage of these soils is rangeland. The main management concerns are suppressing mesquite and keeping a vigorous plant cover on the soil to reduce runoff, evaporation, and erosion. These soils are not used as cropland because of thin spots. The cemented layer in the Mereta soils is undulating beneath the soil surface. In small spots, it comes close to the surface and would be plowed up if it were cultivated. In some places, a limestone ledge 4 to 6 inches thick is also a hindrance to cultivation.

Dwellings and roads can be built on these soils but should be designed to overcome the shrink-swell potential of the soils. The caliche underlying the Mereta soils is good road construction material. Septic tank absorption fields may fail in these soils unless constructed to overcome the moderate soil permeability. Steel pipes should be protected from corrosion.

The Mereta soil is in capability subclass IIIe and the Shallow range site. The Nuvalde soil is in capability subclass IIe and the Clay Loam range site.

NOC—Noelke very cobbly silty clay loam, undulating. These very shallow and shallow, very cobbly soils are on convex limestone hills. Slopes range from 0 to 8 percent. Areas are irregular in shape and range from 20 to 3,000 acres.

Typically, the soil material is grayish brown very cobbly silty clay loam 9 inches thick. Limestone fragments and hard caliche fragments increase with depth. They range from fragments $^{1}/_{8}$ inch in diameter to plates 10 inches across and from 35 to 75 percent of the soil volume. A zone of calcium carbonate accumulation is in the lower part of the soil. This carbonate layer is hard and coats and seals all cracks in the underlying limestone (fig. 11).

Water and air move through this soil at a moderate rate. Surface runoff is rapid. The available water capacity is very low because of the large percentage of fragments and very shallow soil depth. Root development is restricted below a depth of 9 inches by the indurated caliche that coats the underlying limestone. The

Figure 11.—Profile of Noelke very cobbly silty clay loam, undulating.

fragments on the surface help slow runoff and reduce erosion. The hazard of soil blowing is slight, and the hazard of water erosion is moderate.

Included with this soil in mapping are areas that have very thin coatings on the underlying limestone, soils with fewer coarse fragments, and soils with more than 40 percent carbonates. These included soils make up about 15 percent of the total acreage. Small spots of deeper alluvial soil that is 5 percent of the acreage are also included.

All the acreage of this Noelke soil is used as rangeland. A good plant cover must be maintained on rangeland because bare soils having slopes of 0 to 8 percent erode rapidly. Juniper and mesquite have increased in some areas. Controlling the woody plants and maintaining a dense ground cover are the main management concerns.

Noelke soils are not used for crops because they are too cobbly, too shallow, and too steep.

This soil provides a habitat that is excellent for small prairie wildlife, but poor for the larger game animals.

There is not enough cover for quail, deer, and turkey. Pronghorn are suited if properly managed.

Stones and bedrock limit excavating and grading for roads and building sites. Some of the underlying limestone could be crushed for road-surfacing material.

This soil is in capability subclass VIIs and the Limestone Hill range site.

NuA—Nuvalde silty clay loam, 0 to 1 percent slopes. This nearly level soil is in broad flat valleys. Areas are irregular and are 10 to 2,000 acres.

Typically, the surface layer is grayish brown and dark brown silty clay loam 11 inches thick. The subsoil is brown silty clay about 15 inches thick. Below this depth is a pink silty clay loam containing a distinct zone of calcium carbonate accumulation. There is no hard rock within 80 inches of the surface.

Water and air move through this soil at a moderate rate, and surface runoff is slow. The available water capacity is high. The surface layer is friable and easily tilled throughout a fairly wide range of moisture content. On irrigated areas, phosphate fertilizer should be pelleted or placed in bands to avoid its tie-up with the calcium in the soil.

Included with this soil in mapping are small areas of Angelo and Mereta soils. These inclusions make up 10 percent of the total acreage.

A large part of this Nuvalde soil is used as rangeland. Most areas receive and absorb some runoff from adjacent hills, thus partly offsetting the low rainfall. Controlling mesquite and maintaining adequate plant cover are the main management concerns.

About 2,000 acres is used as cropland. The major management concerns are maintaining good tilth and a soil cover for improving water intake and reducing soil temperature, evaporation, soil blowing, and water erosion. Terraces are useful for reducing runoff. Typically, Nuvalde soil areas are large and adjacent to other arable soils. Suitable crops are cotton, grain sorghum, forage sorghum, and small grains. Where irrigation water is available, a wide variety of field crops and vegetable crops can be grown.

Dwellings and roads can be built on this soil but should be designed to withstand the shrink-swell potential and risk of corrosion of the soil.

This soil is in capability subclass IIc nonirrigated and class I irrigated; the range site is Clay Loam.

NuB—Nuvalde silty clay loam, 1 to 3 percent slopes. This deep, gently sloping soil formed in valley fill material. Areas are irregular and range from 10 to 200 acres.

The surface layer is dark grayish brown silty clay loam about 10 inches thick. The next layer is about 18 inches of yellowish brown clay. Between depths of 27 and 50 inches is a pink silty clay loam that is about 20 percent calcium carbonate. Below this, to a depth of 80 inches, is pink silty clay loam with less carbonates.

This Nuvalde soil has slow runoff. Permeability is moderate, and the available water capacity is high. The root zone is deep, and the soil is easily penetrated by roots. The hazard of water erosion is moderate, and the hazard of soil blowing is moderate.

Included with this soil in mapping are small areas of Angelo, Broome, and Mereta soils. These included soils make up about 10 percent of the total acreage.

Most areas of this Nuvalde soil are used as rangeland. The main problems on rangeland are controlling mesquite and maintaining plant cover. Most areas receive runoff and absorb some runoff from adjacent hills, thus partly offsetting the low rainfall.

A small acreage is used for cotton, grain sorghum, forage sorghum, and small grains. Crop residue should be left on the surface to reduce evaporation, soil temperature, soil blowing, and water erosion. Terraces are needed to help prevent erosion, and they are helpful in conserving moisture. All tillage should be on the contour to reduce the speed of runoff. If this soil is irrigated, fertilizer is needed and phosphates should be pelleted to prevent tie-up with calcium compounds in the soil.

Dwellings and roads can be built on this soil but should be designed to withstand the shrink-swell potential and risk of corrosion of the soil.

This soil is in capability subclass IIe nonirrigated and IIe irrigated; the range site is Clay Loam.

OcA—Olton clay loam, 0 to 1 percent slopes. This deep, nearly level, noncalcareous soil is on outwash plains. Areas are irregular in shape and about 10 to 40 acres.

Typically, the surface layer is dark brown clay loam about 8 inches thick. The subsoil, from a depth of 8 to 27 inches, is reddish brown clay loam. From a depth of

27 to 40 inches, it is yellowish red clay loam. From a depth of 40 to 64 inches, it is pink clay loam that contains accumulations of calcium carbonate. The subsoil, from a depth of 64 to 80 inches, is reddish yellow clay loam with some carbonates.

Water and air move through this soil at a moderately slow rate. Surface runoff is slow. The available water capacity is high. The surface layer is friable and easily tilled throughout a wide range of moisture content. The clay content in the subsoil results in moderate shrinking and swelling as moisture content changes.

Included with this soil in mapping are small areas of soils that are now calcareous because of fresh calcareous overwash. Another inclusion is Angelo clay loam. These included soils make up about 5 percent of the mapped areas. Slopes of 1 to 2 percent are in 10 percent of the areas.

All the acreage of this Olton soil is rangeland. Most areas receive and absorb some runoff from adjacent hills, thus partly offsetting the low rainfall. Controlling mesquite, maintaining plant cover, and deferment of grazing so that seeds can mature are the main management concerns.

This Olton soil could be used for cotton, sorghum, and small grains. Many areas are so small that cultivation is impractical. Potential fields are where this soil is adjacent to other soils suitable as cropland. In these areas, minimum tillage and use of crop residue on the surface are helpful in reducing runoff and evaporation. Contour tillage and terraces to slow the runoff and to help conserve moisture may be needed. Because the upper layers are noncalcareous, a wide variety of plants can be grown on this soil if it is irrigated. In this soil, iron is available to plants, while it is much less available in calcareous soils. The mixing of calcareous and noncalcareous layers would destroy this advantage. If irrigated, the common field, orchard, and vegetable crops do well on this soil.

Dwellings and roads can be built on this soil but should be designed with strong foundations to withstand the shrink-swell potential of the soil. Because this soil has moderately slow permeability, septic tank absorption fields should be large.

The capability subclass is IIIe nonirrigated and IIe irrigated, and the range site is Clay Loam.

ReA—Reagan silty clay loam, 0 to 1 percent slopes. This is a deep, nearly level soil in valleys and on alluvial fans. In some places the parent material includes windblown materials. Areas are irregular and range from 10 to 200 acres.

Typically, the soil is calcareous silty clay loam throughout. The surface layer, which is about 8 inches thick, is pale brown. The subsoil, from a depth of 8 to 30 inches, is pale brown and light brown. From a depth of 30 to 80 inches, it is pink and has accumulations of calcium carbonate.

Water and air move through this soil at a moderate rate, and surface runoff is slow. The available water capacity is medium. The surface layer is friable and easily tilled throughout a wide range in moisture content. It does, however, tend to form surface crusts, and rangeland typically has a platy layer about 2 inches thick. Because of the high calcium carbonate content, some crops develop an iron deficiency.

Included with this soil in mapping are small areas of Broome, Conger, and Nuvalde soils. The Broome soils typically are adjacent to flood plains. The Conger soils typically are on higher lying knolls or ridges, and the Nuvalde soils occupy lower areas or drainageways. The included soils make up about 5 percent of the total acreage.

All areas of this Reagan soil are rangeland. The main concerns on rangeland are controlling mesquite and maintaining an adequate plant cover. Deferment of grazing is needed so that plants can produce seed.

If irrigation water becomes available, this would be excellent cropland, and a wide variety of crops could be grown.

Dwellings and roads can be built on this soil but should be designed to withstand the shrink-swell potential and risk of corrosion of the soil. Septic tank absorption fields work well in this soil.

This soil is in capability subclass VIc nonirrigated and class I irrigated; the range site is Loamy.

ReB—Reagan silty clay loam, 1 to 3 percent slopes. This deep, gently sloping soil is in broad valleys. In some places the parent material includes windblown material. Areas are irregular and range from 10 to 200 acres.

In a typical pedon, the upper part of the surface layer is pale brown silty clay loam about 2 inches thick. The lower part of the surface layer is brown silty clay loam about 6 inches thick. The subsoil, from a depth of 8 to 36 inches, is light brown silty clay loam. From a depth of 36 to 64 inches, it is pink silty clay loam with about 15 percent calcium carbonate. From a depth of 64 to 80 inches, it is pink silty clay loam with accumulations of calcium carbonate.

Water and air move through this soil at a moderate rate, and surface runoff is slow. The available water capacity is medium. The surface layer is friable and easily tilled throughout a wide range in moisture content. It tends to form surface crusts, and rangeland typically has a platy surface layer about 2 inches thick. Sorghum crops and some ornamental plants sometimes become yellowish from iron deficiency.

Included in mapping are small areas of Broome, Conger, and Nuvalde soils. The Nuvalde soils occupy lower areas or drainageways. The Conger soils typically are on higher lying knolls or ridges. The included soils are 5 percent of the total acreage.

This Reagan soil is used mainly for range. The main concerns are controlling mesquite and maintaining an adequate plant cover. Deferment of grazing is needed so that range plants can produce seed and improve vigor. If irrigation water becomes available, this is an excellent soil for growing cultivated crops and vegetables.

Dwellings and roads can be built on this soil but should be designed to withstand the shrink-swell potential and risk of corrosion of the soil. Septic tank absorption fields work well in this soil.

This soil is in capability subclass VIe nonirrigated and IIe irrigated; the range site is Loamy.

Ro—Rioconcho silty clay loam, occasionally flooded. This is a deep, nearly level soil on flood plains of the larger streams in the county. Individual areas are 30 to 1,000 acres.

Typically, this soil has a surface layer of grayish brown silty clay loam 24 inches thick. Below this, to a depth of 40 inches, is brown silty clay. The soil becomes pale brown below a depth of 40 inches, and it is more than 80 inches deep (fig. 12).

The available water capacity is high, and the root zone is very deep. The hazards of soil blowing and water erosion are slight. This soil is slowly permeable. Frequency of flooding is between once a year and once in 20 years. When it occurs, flooding lasts about a day.

Included with this soil in mapping are small areas of a bottom land soil that is similar but less clayey. This soil is about 10 percent of the total acreage.

Most of this Rioconcho soil is used as rangeland. Some water is received from flooding, and most areas receive some runoff from higher lying soils. In some areas the water table is within reach of tree roots. The main management concerns are controlling mesquite and maintaining a good plant cover to prevent water erosion.

About 1,300 acres is used as cropland. Most of the cropland is along Dove and Spring Creeks, and about half is irrigated. Forage crops are the most common, including forage sorghums, alfalfa, oats, and winter grasses. Many crops can be grown on Rioconcho soils. Onions, peppers, cantaloupes, and orchard crops such as grapes and pecans grow well under irrigation.

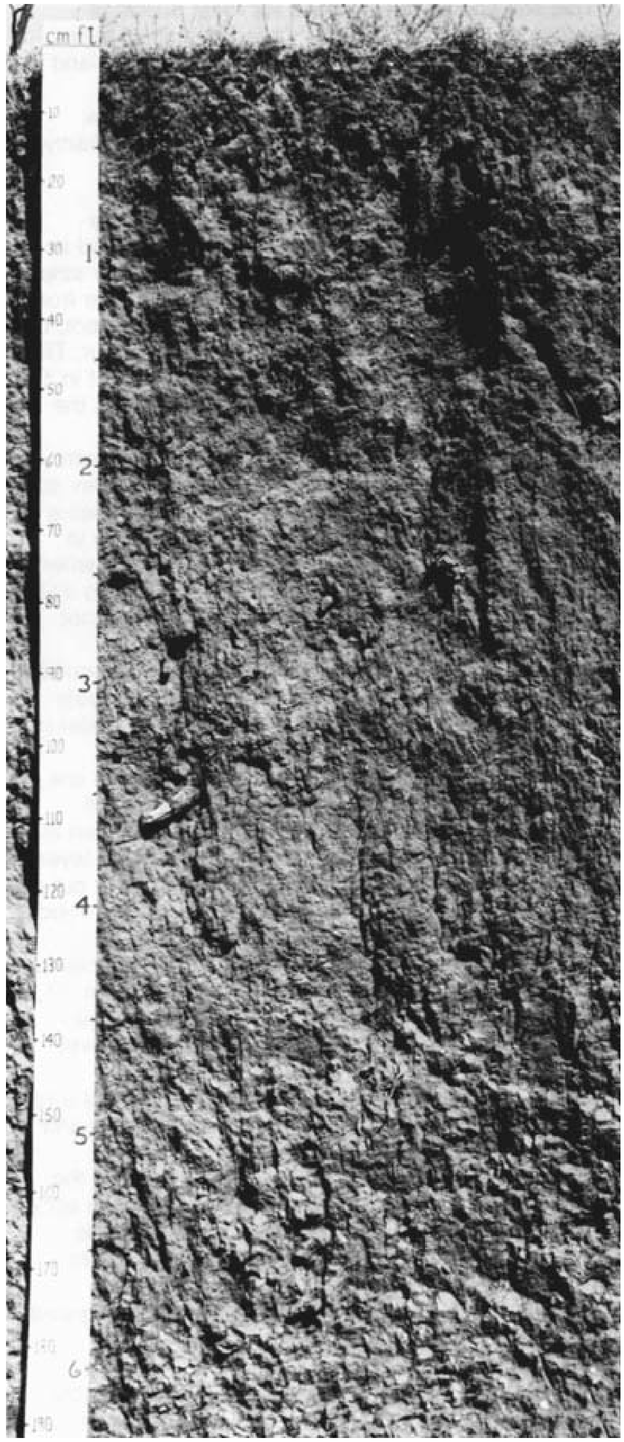

Figure 12.—Profile of Rioconcho silty clay loam, occasionally flooded.

This soil should not be used for most buildings because of the flood hazard. Vegetated picnic areas, trails, and playgrounds would be an appropriate land use.

This Rioconcho soil is in capability subclass IIw nonirrigated and IIw irrigated; the range site is Loamy Bottomland.

RV—Rioconcho-Dev association, frequently flooded. These deep, bottomland soils developed in recent alluvium. They are typically in long narrow strips paralleling the larger streams. Slopes are variable from place to place and range from 0 to about 3 percent, but small areas of very steep streambanks also occur. The gradient of the streams is about 0.001 to 0.2 foot in 100 feet, and runoff is moderate to high. Rarely does the flooding last for more than a day.

The Dev soils typically are adjacent to the stream channel, or the stream channel may consist of Dev soils. The Dev soils may be flooded as often as 10 times a year in the lower areas but only once in 10 years in those areas farthest away from the channel and where the channel is deeply entrenched. The Rioconcho soils are typically at slightly higher elevations and are not flooded quite as often.

Typically, this map unit is about 55 percent Rioconcho and closely similar soils, 35 percent Dev and closely similar soils, and 10 percent stream channels, water in streams, and small areas of Cho and other soils.

The soils closely similar to the Rioconcho soils are less clayey. Some do not have a high shrink-swell potential; some have a dark surface layer less than 20 inches thick; and one has a light-colored surface layer. Areas of these soils could be mapped separately but are mapped as one unit because they are frequently flooded and are similar in use and management.

Typically, the surface layer of the Rioconcho soils is dark gray and dark grayish brown clay loam about 40 inches thick. Below this, to a depth of 80 inches, is grayish brown clay loam with a few limestone gravel strata.

Rioconcho soils are slowly permeable and have a high available water capacity. The risks of soil blowing and water erosion are slight.

Typically, the upper part of the surface layer of the Dev soils is dark grayish brown gravelly clay loam about 8 inches thick. From a depth of 8 to 22 inches, the surface layer is dark brown extremely gravelly loam. Below this, to a depth of 80 inches, is light brown extremely gravelly loam that is about 85 percent gravel (fig. 13).

Dev soils have slow to medium runoff. They are moderately rapidly permeable and have low available water capacity. The risks of soil blowing and water erosion are slight.

Included in mapping are stream channels, mostly of limestone rubble. Vegetation is sparse, consisting of widely scattered grasses and a few trees, such as walnut, live oak, and juniper. The freshly deposited materials are stratified loam, clay loam, and silt loam with varying amounts of gravel. They show evidence of recent deposition and scouring.

Nearly all the acreage is rangeland. This soil is productive because the forage plants and trees benefit from the flooding. Most areas receive runoff from adjacent higher lying soils, thus partly offsetting the low rainfall. Controlling mesquite and maintaining adequate plant cover are the main management concerns.

Rioconcho and Dev soils are not suitable for cultivation because of the flood hazard and the high gravel content of the Dev soils.

Along some of the larger streams are pecan groves, and in other places, pecan orchards could be planted. Maintaining adequate plant cover to reduce runoff, soil temperature, evaporation, and the erosion hazard are the main concerns.

Houses, small dams, and other structures should not be built on these soils because of the flood hazard.

The Rioconcho soil is in subclass Vw and the Loamy Bottomland range site. The Dev soil is in capability subclass VIw and the Draw range site.

TAB—Tarrant very cobbly clay, undulating. This very shallow and shallow soil is on convex hills. A few areas are on flat hilltops. Areas are irregular in shape and range from 10 to 1,200 acres. Slopes range from 1 to 8 percent.

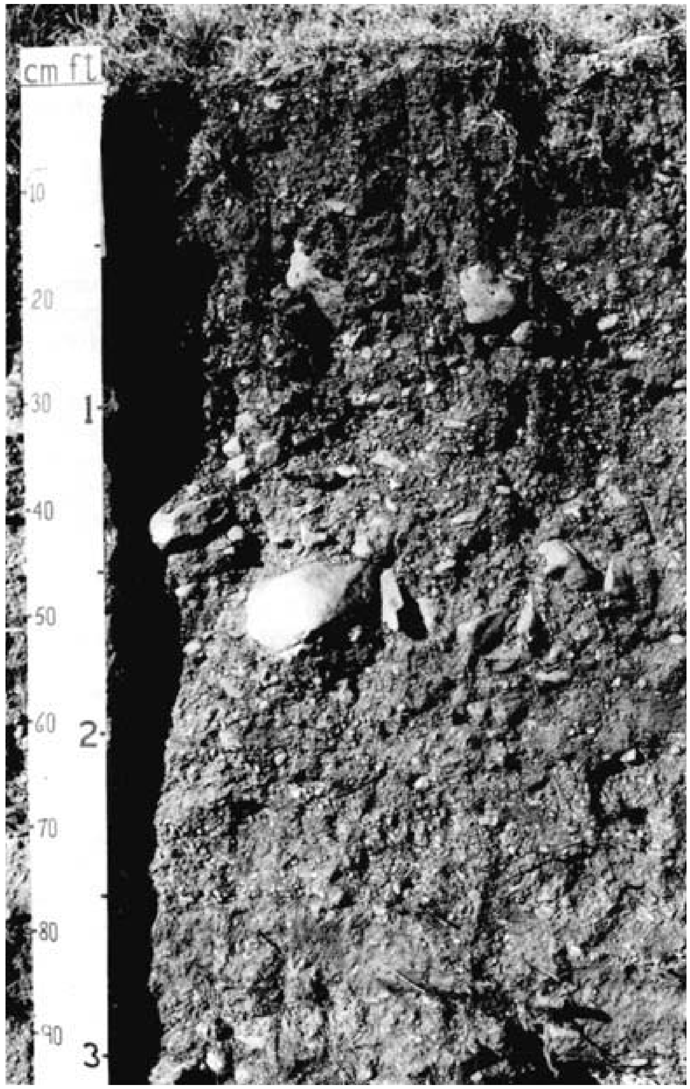

Figure 13.—Profile of a Dev soil in Rioconcho-Dev association, frequently flooded.

Typically, the soil is dark gray and dark grayish brown very cobbly clay about 12 inches thick. Limestone fragments and calcium carbonate concretions increase with increasing depth. They range from $^{1}/_{8}$ inch to 2 feet in diameter and from 35 to 80 percent of the soil volume. A zone of calcium carbonate accumulation is in the lower part. It consists of thin coatings on the limestone bedrock and flattened concretions $^{1}/_{8}$ inch to 3 inches across. The limestone bedrock is cracked, and a little soil and roots are in these cracks.

Water and air move through this soil at a moderate rate. Surface runoff is rapid. The available water capacity is very low because of the shallow soil depth. The soil is droughty; however, plants benefit from rain showers because the large amount of limestone fragments concentrates the rain in the soil around the fragments. Oaks grow on this soil because their roots can penetrate deep into the underlying cracked limestone. Water erosion is moderate if the soil is bare, and any erosion damage is disastrous because the original soil is shallow and new soil develops extremely slowly.

Included with this soil in mapping and making up about 5 percent of the unit are small areas of Tarrant soils with slopes of 8 to 30 percent. Areas of Ector soils also make up 5 percent of the unit.

All the acreage of this soil is rangeland. This Tarrant soil is not used as cropland because it is thin, cobbly, and sloping. It provides habitat that is excellent for deer, turkey, and nongame wildlife but only fair for quail and dove.

Dwellings and roads can be built on this soil, but excavations are difficult because the soil is shallow over bedrock; the topsoil is thin, cobbly, and stony; and the areas are sloping.

The capability subclass is VIIs, and the range site is Low Stony Hills.

ToA—Tobosa clay, limestone substratum, 0 to 1 percent slopes. This deep, nearly level clay is in depressions. Slopes are 0 to 1 percent. Runoff from surrounding areas floods some areas for several weeks after large amounts of rain. Flooding may occur once or twice in 10 years. Areas are rounded and range from 10 to 50 acres.

Typically, the Tobosa soil has a surface layer of dark grayish brown clay about 23 inches thick. Below this, to a depth of about 49 inches, is brown clay. A few caliche fragments and a few soft masses of calcium carbonate are in the lower part of the layer. Below a depth of 49 inches is hard, coarsely fractured limestone.

This Tobosa soil has slow to medium surface runoff. Water enters the soil rapidly when dry and cracked and very slowly when moist. Shrinking and swelling as moisture content changes is very high. The available water capacity is medium. The hazard of water erosion is slight, and the hazard of soil blowing is moderate.

Included in mapping are stony areas, which make up about 10 percent of the total acreage. Also included is a gray clay soil, in the most depressed areas, making up about 10 percent of the total acreage.

This Tobosa soil is rangeland. Mesquite trees have increased in most areas and are a major management concern.

Cotton and grain sorghum could be grown, but the areas are small and isolated, and in some years the crops would drown in the lowest parts of the depressions.

The high clay content and shrinking and swelling as moisture content changes make it necessary to have extremely strong foundations for houses and roads. The risk of corrosion of uncoated steel is high. Excavations are difficult, and septic tank absorption fields must be very large because the permeability is very slow and at times the absorption fields may fail to function.

This soil is in capability subclass IIIs nonirrigated and IIs irrigated; the range site is Clay Flat.

Prime Farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Irion County are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing for the nation's short- and long-range needs for food and fiber. Because the amount of high-quality farmland is limited, it should be used wisely.

Prime farmland soils are those soils best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economical production of sustained high yields of crops. They need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils can be farmed with minimal inputs of energy and economic resources. They produce the highest yields and result in the least damage to the environment.

Prime farmland soils may presently be in use as cropland, pasture, or woodland, or they may be in other uses. They must either be in use for producing food or fiber or be available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few, if any, rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent.

About 33 percent of Irion County is prime farmland. Areas are scattered throughout the county but are mostly in the eastern part in the valleys of Dove and Spring Creeks and the Middle Concho River. About 5,000 acres is used for crops; cotton, grain sorghum, and forage are the most common. Only a small acreage of the prime farmland soils in Irion County has been urbanized. Most of this is adjacent to or on the flood plain of Spring Creek.

Soils that have limitations, such as flooding or inadequate rainfall, may qualify as prime farmland if these limitations are overcome by corrective measures, such as flood control or irrigation. Onsite investigation is necessary to determine whether the corrective measures are effective.

The following map units, or soils, meet the requirements for prime farmland unless the soils are urban or built-up land or they are flooded more than once every 2 years during the growing season. This list is not a recommendation for a particular land use.

AnA	Angelo silty clay loam, 0 to 1 percent slopes
AnB	Angelo silty clay loam, 1 to 3 percent slopes
BrA	Broome silt loam, 0 to 1 percent slopes [1]
BrB	Broome silt loam, 1 to 3 percent slopes [1]
BrC	Broome silt loam, 3 to 5 percent slopes [1]
NuA	Nuvalde silty clay loam, 0 to 1 percent slopes
NuB	Nuvalde silty clay loam, 1 to 3 percent slopes
OcA	Olton clay loam, 0 to 1 percent slopes
ReA	Reagan silty clay loam, 0 to 1 percent slopes
ReB	Reagan silty clay loam, 1 to 3 percent slopes
Ro	Rioconcho silty clay loam, occasionally flooded
ToA	Tobosa clay, limestone substratum, 0 to 1 percent slopes

[1] Prime farmland only where irrigated.

Urban or built-up land is any contiguous unit of land 10 acres or more that is used for residences, industrial sites, commercial sites, construction sites, institutional sites, public administration sites, railroad yards, small parks, cemeteries, airports, golf courses, sanitary landfills, sewage treatment plants, water-control structures and spillways, or shooting ranges.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops, pasture, and range; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops

General management needed for crops is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

The cropland in Irion County covers about 5,200 acres, of which about 1,970 acres is irrigated, according to a survey of irrigated land by the Soil Conservation Service.

Crop yields are kept moderately low by low rainfall, but the potential for increased cropland is high. Prime farmland soils in this county make up more than 200,000 acres. The soils most likely to be converted to cropland are the nearly level Angelo, Nuvalde, and Rioconcho soils, which cover more than 100,000 acres.

Water erosion is a hazard on Angelo silty clay loam, 1 to 3 percent slopes; Broome silty loam, 1 to 3 percent slopes; and Nuvalde silty clay loam, 1 to 3 percent slopes, and also on large expanses of nearly level soil. Runoff can be detrimental on these soils because both soil and water are lost. Plant cover, contour farming, terraces, and grassed waterways help minimize the risk of water erosion.

Soil blowing is a moderate hazard during severe droughts. It can damage land in a few hours if winds are strong and the soils are bare. Usually, the soil has already been damaged when soil blowing is first evident. Maintaining plant cover, surface mulch, or a rough cloddy surface through deep tillage minimizes the risk of soil blowing.

Loss of the surface layer through water erosion or soil blowing is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. This is especially damaging if the soil is shallow or the depth of the root zone is limited by a layer, such as the indurated caliche layer in Mereta soils. Second, water erosion on farmland results in sedimentation of streams. Controlling water erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for fish and other wildlife. Soil blowing results in pollution of the air and deposits drifts of productive soil material along field fences and on roads.

Erosion control practices should reduce runoff, provide protective surface cover, and increase water intake. Close-spaced crops, minimum tillage, leaving crop residue on the surface, emergency tillage, contour farming, field terraces, grassed waterways, and fertilization can all be helpful in controlling erosion. A cropping system that keeps a closely spaced plant cover on the soil for long periods can hold erosion losses to amounts that will not reduce yields. On livestock farms that require much pasture and hay, close-spaced crops may be all that is needed. Minimum tillage keeps the plowed layer from becoming powdery and the subsoil from becoming compacted. This increases water intake and reduces the hazard of runoff. Minimum tillage and proper residue management leave the stubble from the previous crop on the soil surface. Stubble on the surface slows runoff, roughens the surface, prevents soil blowing, reduces soil temperature, and reduces evaporation. Tillage that is done to reduce soil blowing is called emergency tillage. In order to be effective, the surface must be roughened, and tillage must be deep enough to place clods on the surface. Stubble mulch on the surface is more effective than tillage, but when there is none because the previous years were droughty, emergency tillage may be the only practice that can be used for controlling soil blowing.

Contour farming is another erosion control practice used in Irion County. It is best suited to short slopes and to soils that have smooth and uniform slopes. Contour farming is needed on some areas of Angelo, Nuvalde, Broome, and Mereta soils and on all areas that have field terraces. Field terraces reduce the length of slope and slow runoff and erosion. Diversion terraces upslope from cropland divert runoff away from the cropland. Terraces are most practical on deep, well drained soils that have smooth slopes, such as Angelo and Nuvalde soils. Terrace construction on Mereta soils generally cuts into the hard caliche layer. Grassed waterways are needed as outlets for terraces when no rangeland adjoins the cropland. Fertilized crops give more protection against erosion because more plant cover is produced.

Information regarding the design of erosion control practices for each kind of soil is available in local offices of the Soil Conservation Service.

Natural fertility of the deeper soils is medium or high. Farm manure is good for maintaining fertility or for improving it if it is depleted. If large amounts are used, however, the subsequent crop may be damaged in years of drought. Spreading the manure in a thin layer over large areas reduces the damage of overfertilization. Applying commercial fertilizer to nonirrigated land results in some yield increase. Fertilizing irrigated land increases yields substantially. Commercial fertilizer should be applied according to the results of soil tests, the needs of the crop, and the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer needed. The nutrients that have the greatest effect on crop yields are nitrogen and phosphorus.

Tilth is important in the germination of seeds and in the rate of water intake. Soils that have good tilth are granular, porous, and friable. Tilth can be improved by adding large amounts of organic matter, such as animal manure or crop residue. Preparing a good seedbed is difficult in a cloddy soil. Fall plowing generally results in good tilth in spring, but soil blowing may be a concern if the soil is left bare of vegetation.

Crops commonly grown in Irion County are cotton, grain sorghum, wheat, oats, barley, hay and grazing crops, and a small acreage of pecans. Deep irrigated soils that have good natural drainage and that warm up early in the spring are especially well suited to many vegetables, such as tomatoes, onions, squash, carrots, radishes, peppers, okra, beans, spinach, asparagus, eggplant, turnips, beets, and cucumbers. These soils are also suited to some varieties of blackberries and grapes. Pecans are best suited to deep, well-aerated soils that are deeply moistened by floodwater. Pecans are presently grown on some of the Rioconcho and Dev soils, which are well suited. Pecan orchards are also suited to Angelo and Nuvalde soils, but irrigation is necessary. None of the Olton soils are presently farmed, but Olton and Grandfield soils are noncalcareous and, therefore, well suited to crops that are subject to iron-deficiency chlorosis. Peaches, pears, grapes, black-eyed peas, blackberries, and strawberries are vigorous and keep a green color on Olton and Grandfield soils.

The latest information and suggestions on growing new crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Water for irrigation is scarce, and the demand for water for irrigation is constantly increasing. When the water is from wells, the energy needed to pump water is also becoming more expensive. Irrigation should be efficient and should be used only on the best soils. It should be applied uniformly, without water loss, in amounts and at intervals that promote adequate plant growth. Proper irrigation wets the entire root zone so that most of the water is below the rapid evaporation area.

If the system is designed properly and properly used, row irrigation or border irrigation generally is most efficient in Irion County. More labor and more land leveling, however, may be required than for other irrigation methods.

Sprinkler irrigation is less efficient in this hot, dry area. On some windy summer days, as much as 40 percent of the water pumped may be lost through evaporation before it soaks into the soil. Some sprinkler systems wet only the surface layer, where evaporation loss is great. Because sprinklers require water under pressure, pumping costs are greater than for surface irrigation. The advantage of sprinkler irrigation is that little land leveling is required.

Drip irrigation is a recent innovation where the amount of irrigation water is small. It is most often used around homes and vineyards and in newly planted orchards (fig. 14).

Figure 14.—A young pecan orchard being watered by a drip system. The soil is Broome silt loam, 1 to 3 percent slopes.

The best soils for irrigation are level and have a deep root zone and high available water capacity, as exemplified by the Angelo, Nuvalde, and Rioconcho soils.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss of the planted crops.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use. Only certain irrigated soils are in class I in Irion County.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production. There are no class VIII soils in Irion County.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6. The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Rangeland

About 660,000 acres, or 98 percent of Irion County, is rangeland. In 1979, there were an estimated 2,000 angora goats, 21,000 cattle, and 86,000 sheep on the range. In wool production, Irion County ranks sixth in the state. Many white-tailed deer also use the rangeland. In 1979, the number estimated was 29,000.

The Tarrant soils in the southeastern part of the county have the most plant diversity, which includes grasses, forbs, shrubs, and trees. Live oak trees grow on these soils because their roots penetrate deep into cracks in the underlying limestone. Evergreen plants are of utmost importance to grazing animals in January and February and in some years in July and August. Evergreen plants are abundant in this area; therefore, it is the most suitable for deer and goats.

The bottom lands along Dove and Spring Creeks and along the Middle Concho River are the most productive range areas. The soils are deep, can store large amounts of water, and get extra water from higher lying soils. The soils on the bottom lands are Dev and Rioconcho soils. Cattle, sheep, deer, and turkeys all prosper in these areas. Here, Texas needlegrass and Canada wildrye and several forbs are green in the winter and may supply as much as 20 percent of the forage. Rescuegrass is abundant in years of above average winter moisture. It is a short-life grass, but it too is green in January and February and in some years supplies a significant amount of high-protein forage.

The soils in the valleys above normal flood level are the next most productive soils. The most important soils are those in the Angelo, Nuvalde, Broome, and Reagan series. These are all deep soils that are nearly level or gently sloping. Cattle and sheep make the most use of these areas. These soils can store large amounts of water.

The Ector soils are on the limestone hills that make up the rest of the county. These soils are droughty because they are very shallow and low in water storage. The cracks in the underlying limestone are sealed with hard caliche so that live oak trees cannot grow. Sheep, cattle, and some deer use this rangeland.

Many changes in the vegetation have occurred in the past 130 years. These changes were caused by a change in the kinds of grazing animals; by the use of fencing, which caused a change from sporadic to continuous overgrazing; and by a reduction in prairie fires.

The grazing animals once consisted of bison, prairie dogs, pronghorn, deer, and rabbits. The bison and prairie dogs are gone, and the pronghorn are now on only a few ranches on the western side of the county. Sheep, cattle, and goats have replaced these animals. Each group of animals has plant preferences, so the preferred plants were grazed most often. Wire fences made continuous grazing possible. This prevented seed production of the best forage plants and favored spiny or poisonous plants. Spiny and poisonous plants can produce seeds in spite of the continuous presence of grazing animals. Prairie fires were common before the range was fenced but were fought vigorously after fencing because of losses of posts and livestock. Fires tend to favor the bluestem grasses and reduce the threeawns and cacti. Woody plants that sprout from the stumps are not killed by prairie fires, but their seed production and abundance are reduced after many years and many fires.

The most important plant change in the past 130 years has been the increase of woody plants (fig. 15). On Tarrant soils, there is now much more juniper, a little more live oak, and less shinnery oak. Goats have been used to graze out the shinnery oak. On Ector soils, there is now much more juniper. Mesquite has increased on nearly all soils and has increased most on Angelo and Nuvalde soils. Additional changes in the plant community are noted in the range site descriptions.

Plant growth is best during April, May, and June when rainfall and temperatures are most favorable. Another period of growth is during September and October. The fall growth period is very important because most of the winter forage is produced in the fall.

Drought is common in the summer, when low or erratic rainfall in July and August is combined with high evaporation rates. Most supplemental feeding of livestock, however, is done in the coldest part of winter. Deer "die-offs" occur during summer droughts, but winter is a more critical period for cattle.

In the past, cleared land was always the most valuable because removing woody plants increases the water available for forage plants. Now scenic, recreation, and esthetic values determine the land prices in many places. Also, deer and turkey depend on woody plants for much of their food and cover. Woody plant removal is now more selective and is more commonly done in patches and strips.

To achieve maximum, or near maximum, production and still preserve all the plant, soil, and water resources, half the annual plant production should be left ungrazed. This prevents erosion, increases water intake, and keeps the plants growing rapidly. Grasses grow most rapidly when they have a large amount of green foliage. Deferred or intermittent grazing is necessary so that plants can reproduce. Reseeding is necessary on former cropland and on severely overgrazed land.

Some woody plants, such as mesquite, supply only a little forage, use a lot of water, and are overabundant. Here, some thinning or spot clearing would be beneficial to livestock and wildlife. As early as the 1880's, mesquite was invading the prairie in this part of the state. It is now abundant on all the deep and shallow soils. Mesquite has a much deeper root system than grass and withdraws water from

Figure 15.—Mesquite and redberry juniper have changed this prairie to brushland. The soil is Ector very stony loam, hilly.

greater depths. To a large degree, mesquite is responsible for drying up springs or for reducing their flow. When most of the mesquite is removed, many springs and streams flow yearlong.

Juniper is not as deep rooted as mesquite, but when it is overabundant, it too will stop or slow the flow of springs. A good example is West Rocky Creek in the northeastern part of the county. It was a flowing stream when settlers moved into the area. About 1916, it started to dry up in some summers. During the thirties, it dried up completely. Then in the fifties, much of the mesquite was removed from the watershed, and in the mid-sixties the formerly dry springs started to flow again. West Rocky Creek has been restored to a clear, clean stream by the ranchers in the watershed (fig. 16), improving their environment and supplying good water to users downstream.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for each soil, the range site and the potential annual production of vegetation in favorable, normal, and unfavorable years. Explanation of the column headings in table 6 follows.

Figure 16.—West Rocky Creek has been restored to a clear, flowing stream by better use of the rangeland in the watershed. The soils along the banks are in Rioconcho-Dev association, frequently flooded.

A range site is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was established during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Range Sites

In the following paragraphs, the plant community is described for each of the 12 range sites in this county.

Clay Flat range site.—The Tobosa soil in map unit ToA is in this range site. The climax vegetation is short and mid grass prairie consisting of 95 percent grasses and 5 percent perennial forbs.

The potential plant community is tobosagrass, 40 percent; buffalograss, 25 percent; sideoats grama, 10 percent; cane bluestem, 5 percent; vine-mesquite, 5 percent; Texas cupgrass, 5 percent; Texas needlegrass, 5 percent; and perennial forbs, 5 percent.

The sideoats grama, cane bluestem, Texas cupgrass, vine-mesquite, and Texas needlegrass are preferred by livestock and are grazed out first by heavy grazing. These plants are replaced by tobosagrass and buffalograss. Under continued heavy grazing, this soil is invaded by mesquite, lotebush, cactus, red grama, little barley, ozarkgrass, and other annuals.

Clay Loam range site.—The Angelo soil in map units AnA and AnB; the Nuvalde soil in map units NuA, NuB, MnA, and MnB; and the Olton soil in map unit OcA are in this range site. The climax vegetation is a prairie consisting of 90 percent grasses and 10 percent forbs.

The potential plant community is a mid grass prairie. Sideoats grama makes up 25 percent; vine-mesquite, 10 percent; buffalograss and curlymesquite, 20 percent; bluestem, 10 percent; purple threeawn and tobosagrass, 5 percent; Arizona cottontop, 5 percent; plains bristlegrass, dropseed, plains lovegrass, Texas needlegrass, Canada wildrye, fall witchgrass, slim tridens, and reverchon panicum, 15 percent; and forbs such as Engelmann-daisy, gaura, bushsunflower, catclaw sensitivebriar, eveningprimrose, and verbena, 10 percent.

Sideoats grama, vine-mesquite, Arizona cottontop, plains bristlegrass, the bluestems, and Canada wildrye are preferred by livestock, so they are grazed out first by heavy use. They are replaced by buffalograss, curlymesquite, purple threeawn, and tobosagrass. Continued overuse causes further decline of all of these plants and an invasion of mesquite, hairy tridens, threeawns, cactus, lotebush, and red grama.

Draw range site.—Only the Dev soil in map unit RV is in this range site. The climax vegetation is a mid grass prairie consisting of 90 percent grasses, 5 percent forbs, and 5 percent woody plants.

The potential plant community is sideoats grama, 25 percent; cane bluestem, 20 percent; vine-mesquite, 10 percent; buffalograss and curlymesquite, 15 percent; Arizona cottontop, 5 percent; plains bristlegrass, 5 percent; tobosagrass, 5 percent; and Texas needlegrass, 5 percent.

Sideoats grama, cane bluestem, vine-mesquite, and Arizona cottontop are preferred by livestock; therefore, they are grazed out first if grazing is not controlled. These plants are replaced by buffalograss, curlymesquite, tobosagrass, and Texas needlegrass. If heavy grazing continues, the plant community is invaded by threeawn grasses, annual plants, cacti, and thorny plants.

Limestone Hill range site.—The Ector soil in map unit EGB and the Noelke soil in map unit NOC are in this range site. The climax vegetation is an open prairie consisting of 85 percent grasses and 15 percent forbs.

The potential plant community is hairy grama, 10 percent; slim tridens, 10 percent; sideoats grama, 20 percent; cane bluestem, 5 percent; little bluestem, 5 percent; green sprangletop, 10 percent; fall witchgrass, 5 percent; buffalograss, 10 percent; sand dropseed, 5 percent; and Texas needlegrass, 5 percent.

The evergreen plants, perennial forbs, sideoats grama, cane bluestem, and little bluestem are preferred by livestock; therefore, they are grazed out first with heavy grazing. These plants are replaced with juniper (fig. 17), green sprangletop, hairy grama, slim tridens, fall witchgrass, sand dropseed, and buffalograss. Under continued heavy grazing, the site is invaded by mesquite, annuals, hairy tridens, red grama, and several species *of* threeawns.

Figure 17.—Redberry juniper has invaded on this Ector very gravelly loam.

Loamy range site.—The Broome soils in map units BrA, BrB, and BrC and the Reagan soils in map units ReA and ReB are in this range site (fig. 18). The climax vegetation is a prairie with 10 percent perennial forbs, 5 percent woody plants, and 85 percent grasses.

Figure 18.—Much of this Loamy range site is tarbush and burrograss. The soil is Reagan silty clay loam.

The potential plant community is perennial forbs, 10 percent; woody plants, 5 percent; and sideoats grama, 15 percent; buffalograss, 15 percent; tobosagrass, 15 percent; burrograss, 10 percent; vine-mesquite, 5 percent; cane bluestem, 5 percent; fall witchgrass, 5 percent; sand dropseed, 5 percent; and other perennial grasses, 10 percent.

Sideoats grama, cane bluestem, vine-mesquite, and perennial forbs are preferred by livestock; therefore, they are grazed out first with heavy grazing. These plants are replaced by buffalograss, tobosagrass, burrograss, and sand dropseed. Under continued heavy grazing, the areas are invaded by mesquite, annuals, hairy tridens, red grama, and thorny plants.

Loamy Bottomland range site.—The Rioconcho soil in map unit Ro and the Rioconcho soils in map unit RV are in this range site. The climax vegetation is prairie with hardwood forest adjacent to the stream channels.

The potential plant community is 10 percent woody plants, 5 percent perennial forbs, 15 percent sideoats grama, 10 percent indiangrass, 10 percent silver and cane bluestems, 10 percent Canada wildrye, 10 percent vine-mesquite, 5 percent plains lovegrass, 5 percent Texas needlegrass, 5 percent plains bristlegrass, 5 percent tall dropseed, 5 percent buffalograss and curlymesquite, and 5 percent switchgrass.

The perennial forbs, sideoats grama, indiangrass, the bluestems, wildrye, lovegrass, and switchgrass are preferred by livestock; therefore, they are grazed out first with heavy grazing. These plants are replaced by Texas needlegrass, tall dropseed, buffalograss, and curlymesquite. Under continued heavy grazing, this site is invaded by mesquite, many annuals, red grama, hairy tridens, lotebush, and pricklypear cactus.

Low Stony Hills range site.—The Tarrant soil in map unit TAB is in this range site (fig. 19). The climax vegetation is a live oak savannah consisting of 10 percent woody plants, 10 percent forbs, and 80 percent grasses.

Figure 19.—Live oak and many shrubs grow on the Low Stony Hills range site. The soil is Tarrant very cobbly clay.

The potential plant community is 15 percent little bluestem, 15 percent sideoats grama, 5 percent buffalograss, 10 percent curlymesquite, 5 percent green sprangletop, 5 percent Texas needlegrass, 5 percent Texas cupgrass, 5 percent tall dropseed, 5 percent silver bluestem, and 10 percent other perennial grasses. Live oak is the main woody species.

Little bluestem, sideoats grama, Texas needlegrass, Texas cupgrass, silver bluestem, and the perennial forbs are preferred by livestock; therefore, they are grazed out first with heavy grazing. These plants are replaced by buffalograss, curlymesquite, green sprangletop, threeawns, and hairy grama. Under continued heavy grazing, the site is invaded by hairy tridens, red grama, threeawns, juniper, cactus, and many annual plants.

Sandy Loam range site.—The Spade soils in map unit BPC are in this range site. The climax vegetation is a prairie consisting of 90 percent mid grasses, 5 percent forbs, and 5 percent woody plants.

The potential plant community is sideoats grama, 20 percent; plains bristlegrass, 10 percent; cane and silver bluestems, 10 percent; buffalograss, 10 percent; forbs such as dotted gayfeather, prairie-clover, gaura, catclaw sensitivebriar, Engelmann-daisy, Louisiana sagewort, bushsunflower, and croton, 5 percent; blue grama, 5 percent; Arizona cottontop, 5 percent; little bluestem, 5 percent; vine-mesquite, sand dropseed, and hooded windmillgrass, 10 percent; fall witchgrass and black grama, 5 percent; reverchon panicum and Wright threeawn, 5 percent; Texas needlegrass, Canada wildrye, and hairy grama, 5 percent; and 5 percent woody plants, such as catsclaw, ephedra, algerita, wolfberry, hackberry, and yucca.

The evergreen plants, sideoats grama, plains bristlegrass, the bluestems, blue grama, and Arizona cottontop are preferred by livestock; therefore, they are grazed out first by heavy use. They are replaced by buffalograss, fall witchgrass, hooded windmillgrass, hairy grama, and sand dropseed. Continued heavy grazing causes further decline of all those plants and an invasion of red grama, hairy tridens, threeawns, mesquite, pricklypear cactus, and annuals.

Sandy Prairie range site.—The Grandfield soil in map unit GfB is in this range site. The climax vegetation is a prairie consisting of 90 percent mid grasses, 5 percent forbs, and 5 percent woody plants.

The potential plant community is sideoats grama, 20 percent; silver and cane bluestems, 10 percent; plains bristlegrass, 10 percent; buffalograss, 10 percent; little bluestem, 5 percent; reverchon panicum, 5 percent; hooded windmillgrass, 10 percent; sand dropseed, 5 percent; sand lovegrass, 5 percent; blue grama, 5 percent; other perennial grasses, 5 percent; forbs such as prairie-clover, gaura, catclaw sensitivebriar, Engelmann-daisy, Louisiana sagewort, and bushsunflower, 5 percent; and woody plants, such as catsclaw, yucca, ephedra, and hackberry, 5 percent.

The forbs, sideoats grama, the bluestems, and the bristlegrass are preferred by livestock; therefore, they are grazed out first by heavy use. They are replaced by hooded windmillgrass, sand dropseed, and sand lovegrass. Continued heavy grazing causes further decline of all these grasses and an invasion of red grama, hairy tridens, threeawns, mesquite, and annuals.

Shallow range site.—The Mereta soils in map units MnA and MnB, the Conger soil in map unit CnA, and the Blakeney soil in map unit BPC are in this site. The climax vegetation is a prairie consisting of 80 percent grasses, 10 percent perennial forbs, and 10 percent shrubs.

The potential plant community is sideoats grama, 25 percent; buffalograss, 10 percent; sand dropseed, 10 percent; slim tridens, 10 percent; plains bristlegrass, 5 percent; Arizona cottontop, 5 percent; Wright threeawn, 5 percent; cane bluestem, 5 percent; and black grama, 5 percent.

Sideoats grama, plains bristlegrass, Arizona cottontop, cane bluestem, and black grama are preferred by livestock; therefore, they are grazed out first with heavy grazing. These plants are replaced by buffalograss, sand dropseed, and slim tridens. Under continued heavy grazing, this site will be invaded by mesquite, threeawns, hairy tridens, red grama, and a variety of annual plants.

Steep Rocky range site.—The Ector soil in map unit ESE is in this range site (fig. 20). The climax vegetation is a prairie consisting of 75 percent grasses, 10 percent forbs, and 15 percent woody plants.

The potential plant community is sideoats grama, 20 percent; little bluestem, 10 percent; cane bluestem, 15 percent; green sprangletop, 10 percent; hairy tridens, 5 percent; Texas needlegrass, 5 percent; other perennial grasses, 10 percent; bushsunflower, orange zexmenia, Engelmann-daisy, and other perennial forbs, 10 percent; and hackberry, shin oak, elbowbush, algerita, littleleaf sumac, and other shrubs, 15 percent.

Evergreen plants, perennial forbs, sideoats grama, little bluestem, and cane bluestem are preferred by livestock; therefore, they are grazed out first with continuous heavy grazing. These plants are replaced with juniper, green sprangletop, hairy tridens, and fall witchgrass. Under continued overgrazing, the range site is invaded by more juniper, mesquite, hairy tridens, red grama, several species of threeawns, and many annuals.

Very Shallow range site.—The Cho soil in the CHB map unit is in this range site. The climax vegetation is a prairie consisting of 95 percent grasses and 5 percent forbs.

Figure 20.—Area of Ector very stony loam, hilly, in Steep Rocky range site.

The potential plant community is sideoats grama, 30 percent; little bluestem, 10 percent; buffalograss, 10 percent; curlymesquite, 10 percent; Wright threeawn, 10 percent; hairy tridens, 10 percent; slim tridens, 15 percent; and perennial forbs, 5 percent.

The perennial forbs, sideoats grama, and little bluestem are preferred by livestock; therefore, they are grazed out first if grazing is not controlled. These plants are replaced by buffalograss, curlymesquite, Wright threeawn, hairy tridens, and slim tridens. If heavy grazing continues, the plant community is invaded by red grama, mesquite, several species of threeawns, cactus, and many species of annuals.

Landscaping and Gardening

Landscaping is easier if the natural topography and vegetation are preserved during construction. Large cuts and fills are difficult to protect from erosion and difficult to hide. Cuts in Tarrant and Ector soils are especially hard to cover. Large fills make poor foundations, and too much fill over tree roots may kill the tree.

Most yard and garden plants do best in soils that are moist, deep, friable, loamy, and fertile. Because garden areas are small, unfavorable soil characteristics can generally be modified. The hard-to-till clayey surface layer of Angelo, Mereta, Nuvalde, Olton, Rioconcho, and Tobosa soils can be improved by working in organic material, such as compost, manure, or leaves and grass clippings. Working organic material deep into the soil increases the water intake rate. Tobosa soils especially need this because they have a dense clay subsoil.

The depth of the root zone and the large amount of lime in the soils are the most important characteristics of the soil that affect suitability for landscaping and gardening. Large plants, such as pecan, pear, oaks, and grapes, require less care if they are planted on the deepest soils, such as Angelo, Nuvalde, and Olton soils. Dev and Rioconcho soils are also deep, but they are frequently flooded. Topsoil should be added if homes are built on thin soils, such as Ector, Cho, Noelke, and Tarrant soils.

Yellowing of plants, although sometimes a symptom of disease, generally indicates that fertilizer is needed. A good balance of nutrients is essential, and fertilizer should be added according to the results of soil tests.

In general, only the soil to be irrigated should be fertilized. This does not apply, however, to soils that have a sandy surface layer, such as the Grandfield, Blakeney, and Spade soils.

Lime is not needed because all soils in Irion County have an abundant supply of calcium carbonate. The pH of all the soils is near 8.0.

Nitrogen is the main fertilizer needed on lawns. Plants need large amounts of nitrogen to grow rapidly and to keep a dark green color. To obtain the greatest efficiency, nitrogen should be applied as close as possible to time of plant growth. Three applications during the time of plant growth are better than one large application before planting time.

Phosphorus is needed to insure good seed or fruit production. Phosphorus plus nitrogen is usually best for gardens. Phosphorus readily reacts with the calcium compounds in all Irion County soils, forming compounds in which the phosphorus is unavailable to plants. To insure an adequate supply, phosphorus must be added in great quantities or applied in pellet form or as a concentrated band. Phosphorus is not mobile, so it should be applied before planting at a depth where roots will contact it.

Most of the soils in Irion County have an adequate supply of potassium, but potassium should be added if the soils are irrigated. It is essential for high yields.

Adequate amounts of the trace elements, such as boron, copper, zinc, iron, and manganese, are generally present in all the soils or are supplied by an occasional application of manure. The amounts of zinc and iron in the soil are not adequate for all crops. Pecan trees in moderately alkaline soils may need zinc. Periodic foliage sprays containing zinc are the only effective treatment. Peaches, pyracantha, grapes, roses, blackberries, pears, strawberries, beans, black-eyed peas, and St. Augustine grass may show an iron deficiency. Much iron is in all the soils. Like phosphorus, however, iron may form compounds that plants cannot utilize. Iron deficiency is most likely to be a problem on Mereta, Broome, Reagan, Conger, Angelo, Rioconcho (fig. 21), Nuvalde, and Tobosa soils. Iron deficiency is not a problem on Olton and Grandfield soils.

Many soil problems can be corrected by an application of manure. Manure can be applied at rates up to 20 tons per acre. If the manure does not cure an iron deficiency, iron can be supplied by iron chelates in foliage sprays or by iron sulfate or iron chelates in the soil. Sprays on foliage are effective but must be repeated after rain and when new foliage develops. Soil treatment with iron is typically done annually, and it is sometimes more effective if applied in concentrated bands or if the iron sulfate is mixed with about equal parts of sulfur and manure. Compost can be substituted for manure.

For yard and garden plants, the natural soil is usually more attractive than greatly altered areas. Also, native plants that grow naturally at the homesite are nearly always in good health and therefore are more attractive than plants from a different climate. Redbud, western white honeysuckle, desert willow, wild plum, Apache-plume, Texas mulberry, Tracy hawthorn, and golden currant are native shrubs of the county that are worth consideration. The Texas mulberry is a dwarf mulberry no bigger than a redbud. The golden currant is a rare gooseberry with yellow tube flowers and a fragrance like cinnamon. It should be propagated by seeds because rare plants are not made more numerous by digging and transplanting. Fruit maturity begins in July.

Figure 21.—The sorghum in the foreground growing on Rioconcho soils shows symptoms of Iron deficiency.

Recreation

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

By Willard E. Richter, biologist, Soil Conservation Service, San Angelo, Texas.

Irion County has a diverse population of wildlife. Both game species and nongame species are well represented.

Wildlife commonly found in the county are white-tailed deer, turkey, dove, scaled quail, and bobwhite quail. A few ranches have small populations of pronghorn antelope and small bands of collared peccary *(3).*

Some of the more common furbearers are raccoon, fox, striped skunk, opossum, spotted skunk, ringtail, and porcupine. The most common predators are coyote and bobcat.

More than 100 species of birds nest in Irion County. Many more species fly through during their annual migrations. Only a few water areas are large enough to attract waterfowl, and consequently only a few ducks stop over in this area. Rocky Creek, Dove Creek, Spring Creek, and the Middle Concho River provide fishing for bass and catfish.

There are approximately 10 species of lizards, including the roundtail horned lizard, and approximately 30 species of snakes, including the venomous western diamondback rattler, Texas coral snake, and broad-banded copperhead. About 15 species of toads, frogs, turtles, and salamanders can be found in Irion County.

No endangered or threatened wildlife species are endemic to Irion County.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, barley, and milo.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are kleingrass, lovegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, indiangrass, sideoats grama, Engelmann-daisy, sunflowers, and crotons.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are wildplum, agarita, elbowbush, grapes, junipers, sumacs, and lotebush.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, meadowlark, field sparrow, cottontail, and fox.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include pronghorn antelope, deer, turkey, peccary, coyote, bobcat, fox, skunks, ground squirrels, quail, dove, hawks, and numerous songbirds.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction.

The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 10 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill-trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment.

Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 19.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1).*

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 19.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or *2* percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at $^1/_3$ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than *2* millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than *2* millimeters in diameter. The classes are low, a change of less than 3 percent; *moderate,* 3 to 6 percent; and *high,* more than 6 percent. *Very high,* greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Cemented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. A thin pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. A thick pan is more than 3 inches thick if continuously indurated or more than 18 inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as l*ow, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Physical and Chemical Analyses of Selected Soils

The results of physical analysis of several typical pedons in the survey area are given in table 16 and the results of chemical analysis in table 17. Some mineralogical data are given in table 18. The data are for soils sampled at carefully selected sites. The pedons are typical of the series and are described in the section "Soil Series and Their Morphology." Soil samples were analyzed by the National Soil Survey Laboratory, Soil Conservation Service, Lincoln, Nebraska.

Most determinations, except those for grain-size analysis and bulk density, were made on soil material smaller than 2 millimeters in diameter. Measurements reported as percent or quantity of unit weight were calculated on an oven-dry basis. The methods used in obtaining the data are indicated in the list that follows. The codes in parentheses refer to published methods *(9).*

Sand—(0.05-2.0 mm fraction) weight percentages of materials less than 2 mm (3A1).

Silt—(0.002-0.05 mm fraction) pipette extraction, weight percentages of all materials less than 2 mm (3A1).

Clay—(fraction less than 0.002 mm) pipette extraction, weight percentages of materials less than 2 mm (3A1).

Water retained—pressure extraction, percentage of ovendry weight of less than 2 mm material; $^{1}/_{3}$ or $^{1}/_{10}$ ($^{3}/_{10}$) bar (4B1), 15 bars (4B2).

Reaction (pH)—calcium chloride (8C1 e).

Carbonate as calcium carbonate—gravimetric, weight loss (6E1c).

Carbonate as calcium carbonate—gas volumetric (6E1a).

Engineering Index Test Data

Table 19 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil Series and Their Morphology." The soil samples were tested by the State Department of Highway and Public Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); Shrinkage—T 92 (AASHTO), D 427 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(10).* Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll *(Ust,* meaning dry or burnt, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Calciustolls *(Calc,* meaning calcic horizon, plus *ustoll,* the suborder of the Mollisols that have a ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Lithic* identifies a shallow subgroup. An example is Lithic Calciustolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is clayey-skeletal, montmorillonitic, thermic Lithic Calciustolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series. An example is the Tarrant series, which is a member of the clayey-skeletal, montmorillonitic, thermic Lithic Calciustolls.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual *(8).* Many of the technical terms used in the descriptions are defined in Soil Taxonomy *(10).* Unless otherwise stated, colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Angelo Series

The Angelo series consists of deep, loamy, moderately slowly permeable, calcareous soils on uplands. These soils developed in calcareous loamy and clayey sediments. Slopes range from 0 to 3 percent.

Typical pedon of Angelo silty clay loam, 0 to 1 percent slopes; from the Schleicher County line, 2.4 miles north on Farm Road 915, 150 yards west of pens, 10 yards north of cross fence, in rangeland:

A1—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular and moderate medium subangular blocky structure; very hard, firm, sticky and plastic; many fine roots; few fine pores; few fine limestone pebbles; calcareous; moderately alkaline; clear wavy boundary.

A2—7 to 18 inches; dark brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; weak fine granular and strong very fine to medium subangular blocky structure; very hard, firm, sticky and plastic; common fine roots; few fine pores; few earthworm casts; vertical cracks $^{1}/_{2}$ inch wide at 3- to 6-inch intervals; calcareous; moderately alkaline; clear wavy boundary.

Bw—18 to 36 inches; brown (7.5YR 5/4) silty clay, dark brown (7.5YR 4/4) moist; strong very fine and medium subangular blocky structure; very hard, firm, sticky and plastic; few fine roots; few fine pores; few earthworm casts; vertical cracks $^{1}/_{2}$ inch wide at 3-to 5-feet intervals; calcareous; moderately alkaline; gradual wavy boundary.

Bk—36 to 80 inches; pink (7.5YR 7/4) silty clay, brown (7.5YR 5/4) moist; moderate fine and medium subangular blocky structure; very hard, firm; few fine roots; 10 percent visible calcium carbonate in soft masses and concretions 2 to 25 millimeters across; calcareous; moderately alkaline.

The solum thickness ranges from 60 to more than 80 inches. Distinct calcium carbonate accumulations begin at a depth below 24 to 40 inches. The silicate clay content of the 10- to 40-inch section is 28 to 35 percent; total clay ranges from 35 to 50 percent. The silicate clay fraction is dominated by montmorillonite. The coefficient of linear extensibility above the calcic horizon ranges from 0.07 to 0.10.

Thickness of the A horizon ranges from 9 to 24 inches. The A1 horizon in rangeland is silty clay loam. In some cropland, it is mixed with the A2 horizon and is silty clay or clay loam. When the soil is dry, colors are dark grayish brown, dark brown, grayish brown, or brown.

Thickness of the Bw horizon ranges from 10 to 30 inches. This horizon is brown, pale brown, or reddish brown. The texture is silty clay, silty clay loam, clay, or clay loam.

The Bk horizon is 24 to 50 inches thick. Visible calcium carbonate ranges from 10 to 60 percent, as coatings, soft masses, or concretions. The color is pink, brown, light yellowish brown, light brown, strong brown, or very pale brown. Many pedons have rounded limestone pebbles in this horizon. The coefficient of linear extensibility ranges from 0.02 to 0.07.

Blakeney Series

The Blakeney series consists of shallow, loamy, moderately rapidly permeable, calcareous soils over indurated caliche on uplands. These gently sloping soils formed in weakly cemented loamy materials. They are at the base of limestone hills and on knolls. Slopes range from 1 to 5 percent.

Typical pedon of Blakeney fine sandy loam, in an area of Blakeney and Spade fine sandy loams, undulating; from Mertzon, 3.8 miles northeast on U.S. Highway 67, 1.5 miles north on Ranch Road 853, 270 feet east, in rangeland:

A—0 to 7 inches; brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; weak fine granular and weak very fine subangular blocky structure; slightly hard, very friable; few fine roots; few earthworm casts; a weak platy surface crust 5 millimeters thick; few very fine caliche fragments; calcareous; moderately alkaline; clear wavy boundary.

Bw—7 to 14 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; weak fine granular and weak fine and medium subangular blocky structure; slightly hard, very friable; few fine roots; few earthworm casts; common caliche fragments 5 to 100 millimeters across, mostly on top of the Bkm1 horizon; calcareous; moderately alkaline; abrupt wavy boundary.

Bkm1—14 to 16 inches; pinkish white (7.5YR 8/2) indurated platy caliche, pink (7.5YR 8/4) moist; smooth and laminar in top 2 centimeters; calcareous; moderately alkaline; clear wavy boundary.

Bkm2—16 to 36 inches; pink (7.5YR 8/4) moderately cemented fine grained caliche; massive; extremely hard, brittle when moist; about 75 percent calcium carbonate; calcareous; moderately alkaline; diffuse wavy boundary.

Ck—36 to 80 inches; pink (7.5YR 8/4) soft to weakly cemented fine grained caliche of loam texture; massive; very hard, firm; calcium content decreases with depth; a few strata below 60 inches; calcareous; moderately alkaline.

The depth to indurated caliche ranges from 7 to 20 inches. The texture ranges from fine sandy loam to loam with a clay content of 8 to 18 percent.

The A horizon is brown or pale brown.

The Bw horizon is brown, grayish brown, or pale brown. In the shallower pedons, this horizon is missing. Coarse fragments that make up 5 to about 25 percent by volume are mostly just above the underlying petrocalcic horizon.

The petrocalcic horizon is white, very pale brown, pinkish white, or pink. It ranges from 6 to 36 inches in thickness. It is continuously indurated in most pedons, but in a few pedons, it has broken, indurated caliche in plates 1 to 2 inches thick and 6 to 10 inches across.

Broome Series

The Broome series consists of deep, loamy, moderately permeable, calcareous soils on uplands. These soils formed in calcareous loamy sediments. Slopes range from 0 to 5 percent.

Typical pedon of Broome silt loam, 1 to 3 percent slopes; from Barnhart, 22.2 miles north on Texas Highway 163, 3.3 miles east on a caliche road, 60 feet east, in rangeland:

A—0 to 5 inches; light yellowish brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) moist; weak very fine subangular blocky structure; slightly hard, firm, slightly plastic; few fine roots; few earthworm casts; has a 6-millimeter-thick surface crust; calcareous; moderately alkaline; clear smooth boundary.

Btk1—5 to 13 inches; light brown (7.5YR 6/4) silt loam, dark brown (7.5YR 4/4) moist; weak very fine subangular blocky structure; slightly hard, firm, slightly plastic; few fine roots; few earthworm casts; few threads and films of calcium carbonate on peds and in pores; calcareous; moderately alkaline; clear smooth boundary.

Btk2—13 to 19 inches; light brown (7.5YR 6/4) silty clay loam, dark brown (7.5YR 4/4) moist; weak very fine subangular blocky structure; slightly hard, firm, slightly plastic; 20 percent is visible calcium carbonate, mostly soft masses but a few concretions 5 to 15 millimeters in diameter; calcareous; moderately alkaline; gradual wavy boundary.

Btk3—19 to 30 inches; pink (7.5YR 7/4) silty clay loam, brown (7.5YR 5/4) moist; moderate fine subangular blocky structure; slightly hard, firm, slightly sticky; about 5 percent is soft masses of calcium carbonate; a few dark streaks from decaying roots; calcareous; moderately alkaline; gradual wavy boundary.

Btk4—30 to 90 inches; pink (7.5YR 7/4) silty clay loam, brown (7.5YR 5/4) moist; moderate fine subangular blocky structure; slightly hard, firm, slightly sticky and plastic; slightly lighter in color than layer above; about 5 percent is soft masses of calcium carbonate 2 to 10 millimeters in diameter; calcareous; moderately alkaline.

The thickness of the solum is 60 to more than 80 inches. The depth to visible calcium carbonate ranges from 6 to 30 inches.

The texture of the A horizon is dominantly silt loam but is silty clay loam in a few pedons. When the soil is dry, colors are brown, light brownish gray, pale brown, or grayish brown. The A horizon is 6 to 12 inches thick.

The Btk1 horizon is pale brown, light yellowish brown, brown, yellowish brown, light brown, and pink. It is silt loam or silty clay loam. The Btk2 horizon and the horizons below are light brown or pink. The texture is silty clay loam or clay loam that is 20 to 35 percent silicate clay. Secondary carbonates are diffused or occur as soft masses or concretions. They make up 5 to about 30 percent of the horizons.

The Broome soils in Irion County are taxadjuncts to the Broome series. Their chroma are no higher than 4 throughout, which is too low as defined in the range for the series. This difference, however, does not affect the use and management of the soils.

Cho Series

The Cho series consists of very shallow to shallow, moderately permeable, gravelly and loamy soils on undulating uplands. Below the soil is caliche that is undurated in the upper part. Slopes range from 2 to 8 percent.

Typical pedon of Cho gravelly loam, undulating; from the Tom Green County line on Ranch Road 853, 1.1 miles west, 150 feet south, in rangeland:

A—0 to 8 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular and moderate fine subangular blocky structure; hard, friable; few fine roots; 25 percent is indurated caliche fragments $^1/_8$ inch to 2 inches in diameter and has a 40 percent surface cover of the same size caliche fragments; calcareous; moderately alkaline; abrupt wavy boundary.

Bkm—8 to 18 inches; white (10YR 8/2) indurated caliche, very pale brown (10YR 8/3) moist; platy, is 1 to 2 inches thick and 6 to 12 inches across, hardest and smooth on top, rougher below; a few roots and thin seams of soil between upper plates; calcareous; moderately alkaline; gradual wavy boundary.

Ck—18 to 80 inches; white (10YR 8/2) gravelly caliche, light yellowish brown (10YR 6/4) moist; 25 percent is rounded concretions of caliche $^{1}/_{4}$ to 1 inch in diameter; calcareous; moderately alkaline.

The thickness of the solum and depth to indurated caliche range from 7 to 15 inches. The A horizon contains 10 to 35 percent gravel-size fragments of hard caliche, limestone, or siliceous pebbles. A few cobbles are in some pedons. The content of carbonates in the fraction less than 2 centimeters in size is 40 to 60 percent. The texture of the fine material is loam or clay loam. Colors are brown, grayish brown, or dark grayish brown. The Bkm horizon ranges from 2 to 12 inches in thickness. Dry soil has colors of white or very pale brown.

Conger Series

The Conger series consists of shallow, loamy, moderately permeable, gently sloping soils on uplands. These soils formed in calcareous loamy materials. Slopes range from 0 to 3 percent.

Typical pedon of Conger loam, 0 to 3 percent slopes; from the courthouse in Mertzon, 3.8 miles northeast on U.S. Highway 67, 8.6 miles north on Ranch Road 853, 0.5 mile west on a caliche road, 60 yards north:

A—0 to 6 inches; brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) moist; weak very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky; 5 percent is hard caliche fragments from $^{1}/_{8}$ inch to $^{1}/_{2}$ inch in diameter; calcareous; moderately alkaline; clear wavy boundary.

Bw—6 to 17 inches; brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; slightly hard, firm, slightly sticky; 10 percent is caliche fragments from $^{1}/_{8}$ to 1 inch in diameter which increase to 20 percent at the bottom of the horizon; calcareous; moderately alkaline; abrupt wavy boundary.

Bkm—17 to 22 inches; white (10YR 8/1) indurated caliche, very pale brown (10YR 8/3) moist; the caliche is in plates from $^{1}/_{4}$ inch to 4 inches thick; some spots have no soil between the plates; other nearby spots have 20 percent by volume granular soil between the plates; a few roots get through; calcareous; moderately alkaline; clear wavy boundary.

Ck—22 to 72 inches; pink (7.5YR 8/4) silty clay loam, pink (7.5YR 7/4) moist; a few small pebbles; calcareous; moderately alkaline.

The depth to indurated caliche ranges from 12 to 20 inches. The A horizon ranges from 4 to 7 inches in thickness. It is loam or clay loam with a clay content that ranges from 18 to 35 percent. Colors range from pale brown or brown to very pale brown.

The Bw horizon ranges from 5 to 13 inches in thickness. The texture is loam or clay loam with a clay content of 18 to 35 percent. The color is pale brown, brown, very pale brown, or pinkish white.

The Bkm horizon has indurated caliche plates $^{1}/_{4}$ inch to 4 inches thick and 3 to 16 inches across.

Dev Series

The Dev series consists of deep, gravelly, moderately rapidly permeable, loamy soils on bottom lands. These soils are subject to flooding. The slopes are variable because of channeling, and they average less than 1 percent.

Typical pedon of Dev gravelly clay loam in the Rioconcho-Dev association, frequently flooded; from the courthouse in Mertzon, 2.5 miles south on U.S. Highway 67, 8.4 miles south on Ranch Road 915, 0.3 mile west, in rangeland:

A1—0 to 8 inches; dark grayish brown (10YR 4/2) gravelly clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine to medium granular structure; very hard, firm; few fine roots; 25 percent is rounded limestone gravel from $^{1}/_{8}$ inch to 2 inches across, but the majority are less than $^{1}/_{2}$ inch across; calcareous; moderately alkaline; clear wavy boundary.

A2—8 to 22 inches; dark brown (10YR 4/3) extremely gravelly loam, dark brown (10YR 3/3) moist; moderate fine to medium granular structure; hard, firm; few fine roots; 75 percent is rounded limestone gravel from $^{1}/_{8}$ inch to 2 inches across, but the majority is less than $^{1}/_{2}$ inch across; calcareous; moderately alkaline; clear wavy boundary.

Bw—22 to 80 inches; light brown (7.5YR 6/4) extremely gravelly loam, brown (7.5YR 5/4) moist; moderate fine to medium granular structure; hard, firm; few roots; 85 percent is rounded limestone gravel, nearly all of which is less than 1 inch across; calcareous; moderately alkaline.

Dev soils are more than 48 inches deep to limestone bedrock. The texture of the fines ranges from loam to clay loam. The content of coarse fragments ranges from 35 to 85 percent; the majority of the coarse fragments are less than 3 inches in diameter. In some pedons, there are stratified recent sediments in the upper few inches. Some pedons have strata of loam, clay loam, or silty clay loam below a depth of 40 inches, or limestone is below a depth of 48 inches.

The A horizon is 20 to 40 inches thick. Colors are dark grayish brown, grayish brown, dark brown, or brown.

The Bw horizon is light brown, brown, pale brown, light yellowish brown, or very pale brown.

Ector Series

The Ector series consists of shallow and very shallow, loamy, very gravelly and very stony, moderately permeable soils on limestone hills. The soils formed from hard limestone. Slopes range from 1 to 40 percent.

Typical pedon of Ector very gravelly loam, undulating; from the courthouse in Mertzon, 18.6 miles west on Ranch Road 2469, 200 feet north, in rangeland:

A—0 to 6 inches; dark grayish brown (10YR 4/2) very gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular and weak fine subangular blocky structure; slightly hard, friable; few fine roots; about 45 percent is marly limestone and indurated caliche fragments 2 to 8 centimeters across and 20 percent is fragments 2 to 20 millimeters across; calcareous; moderately alkaline; abrupt wavy boundary.

R&Bk—6 to 12 inches; white (10YR 8/2) caliche and limestone plates and marl, very pale brown (10YR 8/4) moist; plates are about 1 inch thick and 4 to 10 inches across; about 10 percent is granular soil in seams; common roots between the plates; coatings of calcium carbonate fill and partly seal cracks and fractures; calcareous; moderately alkaline; clear wavy boundary.

R—12 to 24 inches; white (10YR 8/2) marly limestone, very pale brown (10YR 8/3) moist; cracks are sealed with cemented caliche of about 3 hardness on Mohs' scale; a hard very pale brown limestone stratum is in the lower part.

The solum is 5 to 15 inches thick over limestone bedrock. Content of fragments of limestone or hard caliche ranges from 35 to 80 percent. Forty to 60 percent is calcium carbonate diffused or in aggregates smaller than 2 centimeters across.

Colors of the A horizon are grayish brown, dark grayish brown, or brown. The texture of the fine earth is typically loam but ranges to silt loam, silty clay loam, or clay loam with a clay content of 20 to 35 percent.

Colors of the hard caliche fragments and limestone are white, very pale brown, light gray, and light yellowish brown. The upper 6 to 15 inches of the limestone is coated and has cracks sealed with caliche.

Grandfield Series

The Grandfield series consists of deep, gently sloping, moderately permeable, noncalcareous soils on uplands. These soils formed in colluvial materials or from sandstone. Slopes range from 1 to 5 percent.

Typical pedon of Grandfield fine sandy loam, 1 to 5 percent slopes; from the courthouse in Mertzon, 3.8 miles northeast on U.S. Highway 67, 8.6 miles north on Ranch Road 853, 7.9 miles west on county road, 60 feet north, in rangeland:

A—0 to 9 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; hard, very friable; few fine roots; common earthworm casts; mildly alkaline; clear wavy boundary.

Bt1—9 to 17 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; weak coarse prismatic and weak medium subangular blocky structure; very hard, friable; few very fine roots; few fine pores; common earthworm casts; mildly alkaline; clear wavy boundary.

Bt2—17 to 24 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak coarse prismatic and weak medium subangular blocky structure; very hard, firm; few fine roots; few very fine pores; common earthworm casts; noncalcareous; moderately alkaline; abrupt wavy boundary.

Btk—24 to 35 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak fine and medium subangular blocky structure; very hard, firm; few very fine pores; less red and lighter color in lower part; many films and threads of calcium carbonate; contains a few calcium carbonate concretions 2 to 10 millimeters across; calcareous; moderately alkaline; abrupt wavy boundary.

BCk—35 to 56 inches; pink (5YR 7/4) fine sandy loam, light reddish brown (5YR 6/4) moist; weak fine and medium subangular blocky structure; hard, firm; about 35 percent soft white calcium carbonate and 25 percent concretions 2 to 20 millimeters across; calcareous; moderately alkaline; diffuse wavy boundary.

CBk&CR—56 to 80 inches; pink (7.5YR 8/4) fine sandy loam, light brown (7.5YR 6/4) moist; massive; hard, firm; about 50 percent soft calcium carbonate and about 20 percent calcium carbonate fragments and concretions 2 to 25 millimeters across; about 10 percent thin horizontal strata of unweathered, fine grained sandstone; calcareous; moderately alkaline.

The thickness of the solum ranges from 40 to more than 80 inches. Depth to free carbonates ranges from 24 to 40 inches, and the depth to a distinct calcic horizon ranges from 30 to 60 inches.

The A horizon, when dry, is brown, light brown, dark brown, and reddish brown. The thickness of the A horizon ranges from 5 to 15 inches. The reaction is neutral to mildly alkaline.

The Bt horizons are reddish brown or yellowish red. The reaction is neutral to moderately alkaline. Thickness ranges from 24 to 50 inches.

The BCk and CBk horizons are pink or brownish. Texture is fine sandy loam or sandy clay loam. These horizons contain 15 to 80 percent calcium carbonate. Some have concretions up to 1 inch across.

The Grandfield soils in Irion County are taxadjuncts to the Grandfield series. They have a calcic horizon and are drier for longer periods than is typical for the series.

Mereta Series

The Mereta series consists of shallow, nearly level to gently sloping, moderately slowly permeable soils on uplands. Slopes range from 0 to 3 percent.

Typical pedon of Mereta clay loam in an area of Mereta-Nuvalde complex, 0 to 1 percent slopes; from the Tom Green County line, 1.5 miles west on Ranch Road 853, 60 feet north, in rangeland:

A1—0 to 10 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate fine granular and moderate fine to medium subangular blocky structure; very hard, firm; common fine roots; few very fine pores; 5 percent angular caliche fragments from 2 to 15 millimeters in diameter; calcareous; moderately alkaline; clear wavy boundary.

A2—10 to 16 inches; brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate fine granular and weak fine to medium subangular blocky structure; very hard, firm; few fine roots; 10 percent angular caliche fragments from 2 to 75 millimeters in diameter; calcareous; moderately alkaline; abrupt wavy boundary.

Bkm—16 to 30 inches; white (10YR 8/2) platy and nodular indurated caliche, very pale brown (10YR 7/4) moist; 5 percent is granular soil between the upper plates; the whole horizon appears to be rounded nodules 3 to 10 inches across, bridged and cemented with indurated caliche; calcareous; moderately alkaline; gradual wavy boundary.

Ck—30 to 80 inches; pinkish white (7.5YR 8/2) weakly cemented caliche, pink (7.5YR 8/4) moist; some pockets of reddish yellow (7.5YR 7/6); massive; common very fine pores; calcareous; moderately alkaline.

The depth to indurated caliche ranges from 14 to 20 inches. The texture ranges from clay loam to clay with a clay content of 35 to 45 percent. Coarse fragments on the surface range from 0 to 10 percent by volume and, in the soil above the petrocalcic horizon, from 0 to 10 percent. They are hard caliche, limestone, or chert fragments $^1/_4$ inch to 4 inches across.

The A horizon is brown, grayish brown, and dark grayish brown.

The indurated caliche layer ranges from 3 to 25 inches in thickness. It is platy or platy and nodular. The plates are smooth on top and rougher below. In some pedons, a bit of soil is between the upper plates. The colors are white or very pale brown.

The Ck horizon is 5 to 25 percent by volume rounded pebbles and calcium carbonate concretions $^1/_4$ inch to 2 inches across. The color is white, pinkish white, pink, or very pale brown.

Noelke Series

The Noelke series consists of very shallow and shallow, undulating, moderately permeable soils that contain many limestone fragments. The soils formed in hard limestone. Slopes range from 1 to 10 percent.

Typical pedon of Noelke very cobbly silty clay loam, undulating; from Barnhart, 8.0 miles east on U.S. Highway 67, 50 feet north, in rangeland:

A—0 to 9 inches; grayish brown (10YR 5/2) very cobbly silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine to medium subangular blocky and moderate fine granular structure; very hard, firm, slightly sticky and plastic; many fine roots; few fine pores and few insect burrows up to 3 millimeters in diameter; few wormcasts; about 55 percent coarse fragments consisting of about 15 percent limestone cobbles, smooth on top and roughened below, 25 percent gravel more than 2 centimeters in diameter, and 15 percent gravel less than 2 centimeters in diameter; calcareous; moderately alkaline; abrupt wavy boundary.

Bkm—9 to 12 inches; white (10YR 8/2) indurated caliche, very pale brown (10YR 7/4) moist; caliche is laminated, smooth on top, and continuous horizontally; abrupt wavy boundary.

R—12 to 80 inches; hard, coarsely fractured, white limestone with cracks sealed with cemented carbonates.

Depth to the petrocalcic horizon ranges from 6 to 19 inches. Depth to limestone is 7 to 20 inches. In the A horizon, fragments of limestone or hard caliche make up 35 to 75 percent of the soil. The calcium carbonate content ranges from 25 to 40 percent in the fraction less than 2 centimeters in diameter. Colors are grayish brown and brown. The texture of the fine material is silty clay loam or clay loam with a silicate clay content of 25 to 35 percent.

The Bkm horizon ranges from 1 inch to 18 inches in thickness and extends into cracks in the limestone. It is white or very pale brown.

The R layer commonly is white hard limestone, or in some places it ranges to yellowish, moderately hard limestone. A few pedons have thin layers of yellowish marl below a depth of 40 inches.

Nuvalde Series

The Nuvalde series consists of deep, nearly level to gently sloping, moderately permeable soils on uplands. The soils formed in limy alluvium or outwash in valleys. Slopes range from 0 to 3 percent.

Typical pedon of Nuvalde silty clay loam, 0 to 1 percent slopes; from the courthouse in Mertzon, 7.7 miles east on U.S. Highway 67, 150 feet north, in cropland:

Ap—0 to 5 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular and weak fine subangular blocky structure; very hard, firm; few fine roots; few earthworm casts; calcareous; moderately alkaline; abrupt smooth boundary.

A—5 to 11 inches; dark brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; moderate fine granular and moderate fine to medium subangular blocky structure; very hard, firm; a few fine roots; a few earthworm casts; calcareous; moderately alkaline; clear wavy boundary.

Bw—11 to 26 inches; brown (7.5YR 5/4) silty clay, brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; very hard, firm; few fine roots, few fine pores; few earthworm casts; few threads and very fine soft masses of calcium carbonate in the lower part; calcareous; moderately alkaline; gradual wavy boundary.

Bk—26 to 48 inches; pink (7.5YR 7/4) silty clay loam, light brown (7.5YR 6/4) moist; weak fine subangular blocky structure; very hard, firm; about 30 percent visible soft masses and concretions of calcium carbonate 2 to 10 millimeters across; calcareous; moderately alkaline; gradual wavy boundary.

Ck—48 to 80 inches; pink (7.5YR 7/4) silty clay loam, light brown (7.5YR 6/4) moist; massive; extremely hard, firm; few rounded limestone pebbles 1 to 3 centimeters across; about 10 percent visible soft masses and concretions of calcium carbonate; calcareous; moderately alkaline.

The thickness of the solum and depth to a distinct zone of calcium carbonate accumulation range from 22 to 38 inches. The total clay content ranges from 35 to 50 percent. Silicate clay content ranges from 25 to 35 percent.

The A horizon ranges from silty clay loam to clay loam. The thickness ranges from 10 to 18 inches. Colors are dark grayish brown, grayish brown, brown, or dark brown.

The B horizon is silty clay, silty clay loam, loam, clay loam, or clay 10 to 40 inches thick. Colors are brown, light brown, pale brown, yellowish brown, or pink.

The Ck horizon begins at 22 to 50 inches and extends to 80 inches or more. Colors are pink, pinkish white, or light brown. The visible calcium carbonate occurs as powdery masses or concretions. A few pedons have thin, weakly cemented layers with pores and wormholes. In these pedons, the weakly cemented layers occur 22 to 26 inches below the surface but are mainly deeper.

Olton Series

The Olton series consists of deep, nearly level, moderately slowly permeable soils on uplands. These soils formed in loamy sediments. Slopes range from 0 to 1 percent.

Typical pedon of Olton clay loam, 0 to 1 percent slopes; from the courthouse in Mertzon, 3.8 miles northeast on U.S. Highway 67, 8.6 miles north on Ranch Road 853, 4.3 miles west on a county road, 1.3 miles northwest on a ranch road, 50 yards north, in rangeland:

A—0 to 8 inches; dark brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak fine granular and moderate fine to medium subangular blocky structure; very hard, firm; common fine roots; few earthworm casts; noncalcareous; moderately alkaline; clear wavy boundary.

Bt1—8 to 12 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; weak coarse prismatic structure parting to moderate fine subangular blocky; very hard, firm; common very fine pores; few wormcasts; thin patchy clay films on peds; noncalcareous; moderately alkaline; clear wavy boundary.

Bt2—12 to 27 inches; reddish brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; weak coarse prismatic structure parting to moderate medium blocky; very hard, firm; common very fine pores; few wormcasts; thin clay films on peds; noncalcareous; moderately alkaline; clear wavy boundary.

Btk1—27 to 40 inches; yellowish red (5YR 5/6) clay loam, red (2.5YR 4/6) moist; moderate medium blocky structure; very hard, firm; common fine pores; patchy clay films on peds; common threads and films of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

Btk2—40 to 64 inches; pink (5YR 7/4) clay loam, reddish brown (5YR 5/4) moist; weak very fine granular and very fine subangular blocky structure; very hard, firm; common fine pores; about 50 percent calcium carbonate, 25 percent is concretions 2 to 25 millimeters across; calcareous; moderately alkaline; gradual wavy boundary.

Btk3—64 to 80 inches; reddish yellow (5YR 6/6) clay loam, yellowish red (5YR 5/6) moist; weak fine subangular blocky structure; very hard, firm; many fine pores; about 20 percent calcium carbonate, 10 percent is concretions 2 to 25 millimeters across; calcareous; moderately alkaline.

The thickness of the solum ranges from 60 to more than 80 inches. Depth to secondary carbonates ranges from 14 to 28 inches. Depth to a distinct zone of calcium carbonate accumulation ranges from 30 to about 45 inches.

The A horizon is 6 to 12 inches. Colors are dark brown, brown, reddish brown, grayish brown, or dark grayish brown.

The Bt horizons above the calcic horizon are reddish brown, brown, dark brown, or yellowish red. Colors in and below the calcic horizon are light brown, pink, reddish yellow, reddish brown, and light reddish brown. The calcium carbonate content in the calcic horizon ranges from 15 to 60 percent. Texture of the Bt horizon is clay loam or clay with 35 to about 45 percent clay.

Reagan Series

The Reagan series consists of deep, nearly level to gently sloping, moderately permeable soils. These light-colored soils formed in outwash material. Slopes range from 0 to 2 percent.

Typical pedon of Reagan silty clay loam, 1 to 3 percent slopes; from Barnhart, 12.3 miles north on Texas Highway 163, 0.3 mile east on Ranch Road 2469, 180 feet north, in rangeland:

A1—0 to 2 inches; pale brown (10YR 6/3) silty clay loam, dark brown (10 YR 4/3) moist; weak thin platy structure; hard, firm; few fine roots; calcareous; moderately alkaline; clear smooth boundary.

A2—2 to 8 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate fine granular and moderate fine to medium subangular blocky structure; hard, firm; few fine roots; few fine pores; calcareous; moderately alkaline; gradual wavy boundary.

Bw—8 to 36 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; moderate very fine to medium subangular blocky structure; few fine roots; few fine pores; few white specks of calcium carbonate about 1 millimeter across; calcareous; moderately alkaline; clear wavy boundary.

Bk1—36 to 64 inches; pink (7.5YR 8/4) silty clay loam, light brown (7.5YR 6/4) moist; moderate fine to medium subangular blocky structure; hard, firm; 15 percent is calcium carbonate concretions $^1/_8$ to $^1/_3$ inch in diameter; calcareous; moderately alkaline; gradual wavy boundary.

Bk2—64 to 80 inches; pink (7.5YR 7/4) silty clay loam, light brown (7.5YR 6/4) moist; moderate fine to medium subangular blocky structure; hard, firm; a few concretions of calcium carbonate from $^1/_8$ to ¼ inch in diameter; calcareous; moderately alkaline.

The thickness of the solum ranges from 40 to 80 or more inches. Depth to the Bk horizon ranges from 20 to 36 inches.

The texture of the A horizon is silty clay loam, but in most pedons a platy surface crust of silt loam is 1 to 2 inches thick. The crust is commonly grayer than the remainder of this horizon. The colors are pale brown, brown, and light brownish gray. Thickness ranges from 4 to 12 inches.

The B horizon has a silicate clay content of 18 to 35 percent. Total clay content ranges up to 45 percent. Less than 15 percent is fine sand or coarser. The colors are light brown, pale brown, pink, and very pale brown.

The calcic horizon has from 5 to 70 percent visible calcium carbonate with or without concretions. The colors are pink or pinkish white.

Rioconcho Series

The Rioconcho series consists of deep, nearly level, slowly permeable soils on flood plains. The soils formed in clayey and limy alluvial sediments. Slopes range from 0 to 1 percent.

Typical pedon of Rioconcho silty clay loam, occasionally flooded; from Barnhart, 22.2 miles north on Texas Highway 163, 4.5 miles east on a caliche road, 50 feet south, in rangeland:

A1—0 to 24 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular and moderate very fine to medium subangular blocky structure; very hard, firm; few fine roots; few fine pores; few earthworm casts; vertical dry weather cracks ¼ inch wide; platy surface crusting in the upper 2 inches; calcareous; moderately alkaline; gradual wavy boundary.

A2—24 to 40 inches; brown (10YR 5/3) silty clay, dark brown (10YR 3/3) moist; moderate medium blocky structure; extremely hard, very firm, sticky and plastic; few fine roots; few fine pores; calcareous; moderately alkaline; gradual wavy boundary.

Bk—40 to 80 inches; pale brown (10YR 6/3) silty clay, brown (10YR 4/3) moist; moderate medium blocky structure; extremely hard, very firm, sticky and plastic; few concretions and soft masses of calcium carbonate $^{1}/_{8}$ to ¼ inch in diameter, diminishing with depth; calcareous; moderately alkaline.

The thickness of the solum is 50 to 80 or more inches. The dark surface layers are 20 to 50 inches thick. Texture ranges from clay loam or silty clay loam to silty clay; the clay content is more than 35 percent. Dry weather cracks are $^{1}/_{3}$ to 1 inch wide and extend to 40 inches or more in depth. When the surface layer is dry, colors are grayish brown, dark grayish brown, and brown.

The Bk horizon is pale brown, brown, or light brownish gray. Gravelly strata are present in some pedons below a depth of 40 inches.

Spade Series

The Spade series consists of moderately deep, moderately rapidly permeable, calcareous loamy soils over sandstone. These undulating soils formed from weakly to strongly cemented sandstone. Slopes range from 1 to 8 percent.

Typical pedon of Spade fine sandy loam, in an area of Blakeney and Spade fine sandy loams, undulating; 3.8 miles northeast of Mertzon on U.S. Highway 67, 1.5 miles north on Ranch Road 853, 50 feet east, in rangeland:

A—0 to 11 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; weak fine granular and weak very fine to medium subangular blocky structure; slightly hard, friable; few fine roots; few fine pores; common earthworm casts; few caliche fragments from 2 to 10 millimeters across; calcareous; moderately alkaline; clear wavy boundary.

Bk1—11 to 23 inches; very pale brown (10YR 7/3) fine sandy loam, brown (10YR 5/3) moist; weak fine granular and very fine to medium subangular blocky structure; slightly hard, friable; few fine roots; few fine pores; common earthworm casts; common caliche fragments from 2 to 20 millimeters across; few threads and films of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

Bk2—23 to 30 inches; very pale brown (10YR 7/4) fine sandy loam, yellowish brown (10YR 5/4) moist; weak very fine to medium subangular blocky structure; hard, friable; few fine roots; few earthworm casts; about 20 percent calcium carbonate concretions from 2 to 25 millimeters across; calcareous; moderately alkaline; gradual wavy boundary.

Bk/Cr—30 to 36 inches; very pale brown (10YR 8/4) fine sandy loam, light yellowish brown (10YR 6/4) moist; slightly hard, friable; weathered sandstone fragments coated with calcium carbonate; about 35 percent

calcium carbonate with a few concretions from 2 to 25 millimeters across; calcareous; moderately alkaline; clear wavy boundary.

R—36 to 80 inches; pale yellow (2.5Y 8/4) fine grained sandstone, pale yellow (2.5Y 7/4) moist; coarsely fractured, with calcium carbonate in seams in upper 12 inches; calcareous; moderately alkaline.

Thickness of the solum, or depth to bedrock, ranges from 20 to 40 inches. The texture is loam or fine sandy loam that has a clay content of 10 to 18 percent.

The A horizon is pale brown, brown, yellowish brown, or light brown. Some pedons are noncalcareous in the A horizon.

The B horizon is light yellowish brown, pale brown, brown, very pale brown, or yellowish brown.

The Bk/Cr horizon is 5 to 75 percent calcium carbonate occurring in seams of the weakly cemented sandstone and as concretions and soft masses of calcium carbonate.

The R layer is white, brownish, or yellowish, fine grained, weakly to strongly cemented sandstone apparently of the Antlers Formation. It is weakly calcareous to strongly calcareous.

Tarrant Series

The Tarrant series consists of very shallow and shallow, undulating, moderately slowly permeable clayey soils over hard limestone. More than 35 percent of the soil material is limestone fragments of stone, cobble, and pebble size. The underlying limestone is fractured. The cracks are open. The slopes range from 1 to 8 percent.

Typical pedon of Tarrant very cobbly clay, undulating; from the courthouse in Mertzon, 3.7 miles south and west on U.S. Highway 67, 100 feet north, in rangeland:

A—0 to 11 inches; dark gray (10YR 4/1) very cobbly clay, black (10YR 2/1) moist; moderate fine granular and weak fine to medium subangular blocky structure; very hard, firm; common very fine roots; few earthworm casts; 30 percent is limestone cobbles and 15 percent is limestone of gravel size; on the surface stones are 20 feet apart and cobbles are 2 feet apart; calcareous; moderately alkaline; clear wavy boundary.

Ak—11 to 12 inches; dark grayish brown (10YR 4/2) very gravelly clay, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; hard, firm; few very fine roots; 80 percent is limestone fragments and cemented calcium carbonate nodules from $^1/_2$ inch to 3 inches across, somewhat flattened; most limestone fragments have a thin coating of hard caliche; calcareous; moderately alkaline; abrupt wavy boundary.

R—12 to 30 inches; white (10YR 8/1), hard and moderately hard, coarsely fractured limestone, very pale brown (10YR 8/3) moist; thin coatings of cemented caliche are on the surface and in some of the cracks, but most cracks contain soil and roots and extend to several feet; calcareous; moderately alkaline.

The solum thickness over hard limestone ranges from 6 to 17 inches. The solum is 35 to 80 percent limestone fragments ranging in size from fine gravel to stones 4 feet across. The percentage of fragments increases with increasing depth. Two-thirds of the pedons have stones, and nearly all have cobbles and pebbles. The soil mass is less than 20 percent pebbles that are less than 2 centimeters in diameter. The texture of fine material is clay or silty clay with the clay content ranging from 40 to 50 percent. Colors are grayish brown, dark grayish brown, dark gray, and dark brown.

Secondary carbonates, mostly in the lower part of the solum, occur as powdery coatings, concretions, or indurated coatings less than 1 inch thick on fragments or on the underlying limestone.

The color of the limestone is white, light gray, and very pale brown.

The Tarrant soils in Irion County are taxadjuncts to the Tarrant series. They are dry in the moisture control section for longer periods of time than the soils described as typical of the series.

Tobosa Series

The Tobosa series consists of deep, nearly level, very slowly permeable clays that form wide cracks as they dry and have weakly expressed microrelief. Slopes are nearly level or slightly depressional and are less than 1 percent.

Typical pedon of Tobosa clay, limestone substratum, 0 to 1 percent slopes, about 6.75 miles northeast of Barnhart; or 1.0 mile west and 1.7 miles north of USGS triangulation station Monte, in rangeland:

A1—0 to 11 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate fine granular and moderate very fine to medium subangular blocky structure; extremely hard, very firm, sticky and plastic; common fine roots; few earthworm casts; calcareous; moderately alkaline; gradual wavy boundary.

A2—11 to 23 inches; dark grayish brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate very fine to medium blocky structure; extremely hard, very firm, sticky and plastic; few fine roots; 1 centimeter wide cracks are filled with soil from horizon above; most peds are wedge shaped; few limestone fragments from 5 to 25 millimeters across; calcareous; moderately alkaline; gradual wavy boundary.

AC—23 to 49 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; moderate very fine to medium blocky structure; extremely hard, very firm, sticky and plastic; few limestone fragments from 5 to 25 millimeters across; most peds are wedge shaped; darker material in filled cracks; few caliche fragments and very fine soft masses of calcium carbonates in lower 7 inches; calcareous; moderately alkaline; abrupt wavy boundary.

R—49 to 60 inches; hard, coarsely fractured, very pale brown limestone; upper few inches coated and sealed with calcium carbonate.

The solum is 40 to 60 inches thick. When dry, these soils have cracks as much as 3 inches wide extending well into the AC horizon. Unplowed areas have gilgai microrelief, mostly as small depressions 1 to 6 inches deep and from 2 to 12 feet across. The clay content ranges from 45 to 60 percent.

The thickness of the A horizon ranges from 16 to 44 inches. Colors are dark grayish brown or grayish brown.

The AC horizon ranges from 20 to 32 inches in thickness.

A zone of calcium carbonate accumulation is present in nearly all pedons. It ranges from a few soft masses to a layer 34 inches thick. Some pedons have coatings of calcium carbonate on top of the underlying limestone. The hard limestone is below a depth of 40 inches.

Factors of Soil Formation

Soil is formed by the action of soil-forming processes on material deposited or accumulated by geological agencies. The characteristics of a soil at any given point depend on (1) the physical and mineral composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material. All five of these factors are important in the development of every soil, although some have had more influence than others in different locations.

Parent Material

Parent material is the unconsolidated mass from which a soil forms. The kind of parent material determines the rate of profile formation, the kind of profile that forms, and the chemical and mineral composition of the soil. It also influences the relief.

In Irion County, the soils developed in material weathered from rock of Lower Cretaceous age and in alluvium derived from those formations. The rock is high in calcium carbonate; therefore, nearly all the soils in the county are calcareous. The rock ranges from hard limestone to marl and varies in hardness. The marl consists chiefly of calcium carbonate mixed with varying amounts of clay.

The hardness of the limestone influences soil depth. The softer limestone and marl weather to soil more readily than hard limestone, so the soils formed in the softer material are deeper. An example is Tobosa soils. Because the harder and more resistant limestone weathers more slowly, the soils that formed in hard limestone are shallower. Tarrant and Ector soils formed in harder material.

The hardness of the limestone also influences soil slope. A thick, hard limestone layer is so resistant to weathering that it forms a protective caprock on many hills. This caprock protects the material under it, but the adjacent slopes wear down and become steeper, as in Ector very stony loam, hilly, for example. Limestone of intermediate hardness tends to form a landscape of lower, rounded hills. Examples are Ector very gravelly loam, undulating, and Noelke very cobbly silty clay loam, undulating.

Old alluvium is the parent material of Angelo, Nuvalde, and Broome soils, and recent alluvium is the parent material of Dev and Rioconcho soils. Because deep, loose alluvial deposits allow soil to develop to a great depth, these soils are the deepest in the county.

Climate

Climate influences the formation of soils directly through rainfall, evaporation, temperature, and wind and indirectly through its influence on relief and on the amount of plant and animal life. The change is fastest when the soil is moist and warm. Most of the differences between the soils in this county cannot be attributed to differences in climate alone because the climate is uniform. Because the annual rainfall is low and evaporation is high, there is an accumulation of minerals in the soils and little leaching. Nearly all the soils are calcareous throughout, and all are high in content of plant nutrients. Water carries calcium carbonate downward into the soil. For this reason, most of the soils have a distinct zone of calcium carbonate accumulation at the normal depth of water penetration.

In deeper soils, such as Angelo, Nuvalde, Broome, and Tobosa soils, the zone of accumulation is diffused. In shallower soils, such as Ector, Mereta, Cho, Noelke, and Conger soils, it is concentrated and cemented (fig. 22).

Plant and Animal Life

Plants, micro-organisms, earthworms, insects, and larger animals that live in or on the soil all contribute to soil formation.

Grasses contribute large amounts of organic matter to the soil, and their fibrous root systems help to keep the soil porous and granular. Decayed organic matter darkens soils. Soils that have a thick dark surface layer, such as Angelo, Nuvalde, Dev, Rioconcho, Mereta, Noelke, Olton, Tarrant, Ector, and Tobosa soils, make up about 90 percent of the county.

In some places, tree roots have loosened the rock beneath the soil, making it possible for other plant roots to penetrate to greater depths. This is especially evident in the Tarrant soil.

Figure 22.—Most limestone fragments in Ector soils have an indurated caliche coating on the bottom. Caliche also seals cracks in the underlying limestone.

Micro-organisms, such as fungi and bacteria, help to decompose organic matter and to break down parent material, all of which improves fertility. Burrowing animals, such as ants, earthworms, cicadas, ground squirrels, and badgers, improve soil structure and thereby aid the movement of water and the growth of plant roots.

Man too affects soil formation. Some of his activities drastically change soils. Plowing mixes the upper layers, hastens the decay of organic matter, reduces the water intake rate, and bares the soil to blowing and water erosion. During construction, soils are excavated, buried, or mixed with nonsoil material. Some are leveled or made deeper.

Relief

Relief is influenced by geology, climate, and time. Relief influences soil formation through its effect on drainage, runoff, and erosion. The hilly or undulating Tarrant, Ector, Noelke, and Cho soils lose much rainfall through runoff. All are very shallow because little moisture is available for living organisms and because soil is lost through water erosion nearly as fast as it forms. The nearly level Nuvalde, Olton, Tobosa, Rioconcho, and Angelo soils are deep because they absorb a lot of moisture. These soils receive runoff from higher soils. Mereta and Conger soils are intermediate in depth and in the amount of water absorbed.

Time

A long time is required for the soil-forming factors of climate, plant and animal life, and relief to act on the parent material.

The first easily recognized step in soil formation is a darkening of the surface layer caused by the decay of organic matter. At first, there is only a thin layer; this darkens and thickens with time.

A second step is the development of a subsoil with structure and some chemical changes, such as leaching of bases. This is the stage of development of the Dev and Rioconcho soils. Because the parent material of these soils is recent, time has been inadequate to reach a third step.

A third step is the removal of calcium carbonate from the solum and its redeposition below as a zone of calcium carbonate accumulation. At early stages, only a small amount of calcium carbonate is visible at the normal depth of saturation. At later stages, a distinct layer containing some calcium carbonate concretions is visible. Angelo and Nuvalde soils are at this stage. In the final stage, an indurated caliche layer forms. Conger, Mereta, Cho, and Blakeney soils have reached this stage.

Another step in development occurs after all the free carbonates have been leached from the solum. Carbonates immobilize clay particles. After the carbonates have been removed, clay is moved downward with the soil water and is redeposited in the subsoil. This causes a distinct difference in clay content between the topsoil and the subsoil. This is the stage of development of the Olton and Grandfield soils. Broome soils also have reached this stage of development, but sometime after the clayey subsoil developed they became recalcified. This may have been caused by a climate change many hundreds of years ago, by prairie dogs that piled highly calcareous materials on the surface, or some other, unknown reason.

Tobosa soils do not fit the preceding development pattern. When dry, these soils have wide cracks into which surface soil material falls. When wet, the soil expands, the cracks close, and some soil material is forced upward. With new material at the surface, soil formation must start again.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazingland for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Arabic numeral 2 precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Peres slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Tables

The tables in this soil survey contain information that affects land use planning in this survey area. More current data tables may be available from the Web Soil Survey at the Tabular Data tab.

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